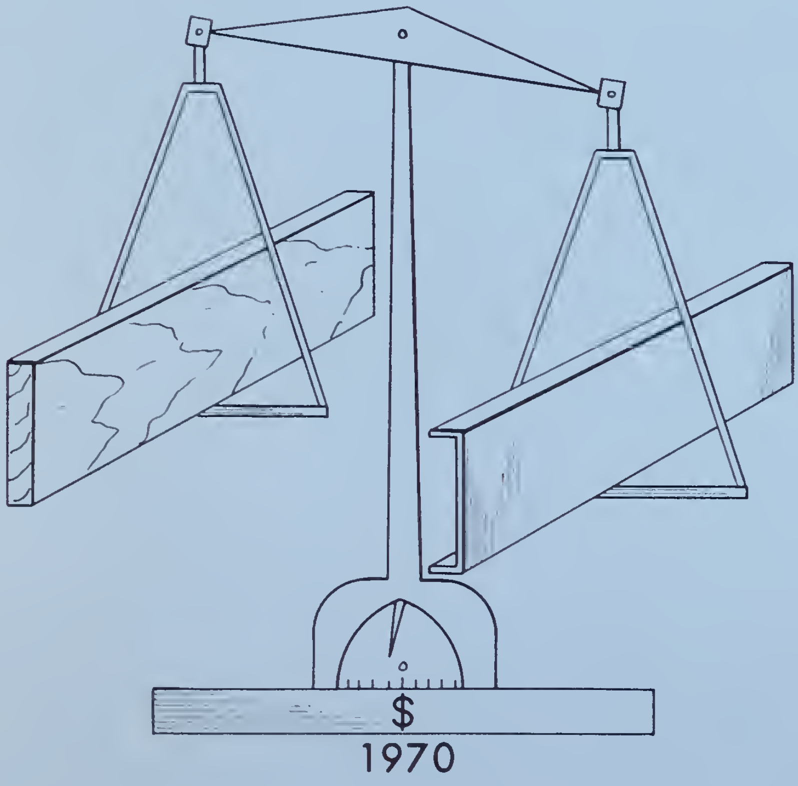
Historic, archived document

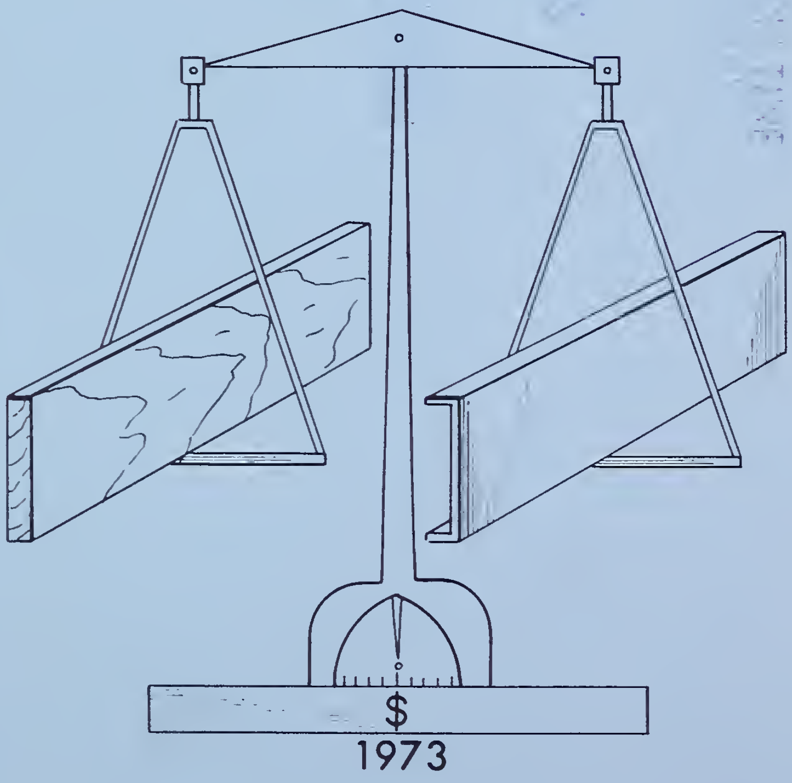
Do not assume content reflects current scientific knowledge, policies, or practices.

Reserve
A99.9
F76Us

Comparative In-place Cost Between Wood and Aluminum Residential Floor and Wall Framing 1970 and 1973

by
Maurice G. Wright
and
Gerald A. Koenigshof





U.S. Department of Agriculture
Forest Service

Research Paper WO-29

662572

1725198

Comparative In-place Cost
Between Wood and Aluminum
Residential Floor and Wall Framing

Maurice G. Wright and Gerald A. Koenigshof
Forest Economics and Marketing Research Staff

Research Paper WO-29

U.S. Department of Agriculture Forest Service

June 1975

PREFACE

The largest use made of lumber in residential construction is for structural framing. In determining the demands on lumber, we should know the effects that changes in material and labor costs have upon in-place costs of wood and aluminum framing installations.

This is the second study of this type done by the Forest Service. The first was entitled "Comparative In-place Cost Between Wood and Steel Residential Floor and Wall Framing," by Gerald A. Koenigshof. This study closely parallels the earlier one, but differs in two major respects. First, the study periods used for comparisons are the average in-place costs for 1970 and the in-place costs for the period of peak lumber and plywood prices during 1973, which embraced the last 2 weeks of March and the first week of April. Second, the labor rates used were the union wage rates for the cities selected for the study.

Data for both periods in this study were taken from "Comparative In-place Cost Between Wood and Steel Residential Floor and Wall Framing," and covered such items as:

1) Quantities of lumber per square foot of floored area
2) Quantities of plywood per square foot of floored area
3) Quantities of lumber per linear foot of interior partitioned area
4) Quantities of lumber per linear foot of exterior wall area
5) Labor requirements per square foot of floored area
6) Labor requirements per linear foot of interior partitioned area
7) Labor requirements per linear foot of exterior wall area

Lumber and plywood prices for 1970 were also taken from the aforementioned study.

It should be kept in mind that aluminum and lumber prices were at their extreme high in the 1973 study period and data given do not necessarily reflect the usual price relationship.

A range in the typical quantities of labor and material used for different types of construction and representative averages are presented in the tables in this report.

The Forest Service wishes to acknowledge the time and effort of those who generously supplied information for this report, among them:

Lee Fisher, National Association of Home Builders
Research Foundation, Inc.
Fred Reseburg, Western Wood Products Association
William Dean, Random Lengths Publishing Company
Robert Hossli, Reynolds Metals Company
David Countryman, American Plywood Association
A.J. Heineman, Weyerhaeuser Company
William Ganser, Southern Forest Products Association

Wright, Maurice G. and Koenigshof, Gerald A.

1975. Comparative in-place cost between wood and aluminum residential floor and wall framing, 1970 and 1973. USDA Forest Serv. Res. Pap. WO-29, 62p.

During 1970, in-place costs of material and labor for wood framing for floors, interior partitions, and exterior walls maintained a distinct cost advantage over aluminum framing (for these items). However, at the peak prices paid for lumber and plywood during the spring of 1973, wood-framed floors were roughly equivalent, wood-framed interior partitions lost much of their cost advantage, and wood-framed exterior walls were at a distinct economic disadvantage when compared to aluminum framing for these three items. Lumber and plywood prices have since declined; thus the cost relationship between wood framing and aluminum framing closely approaches that for the year 1970.

Keywords: Residential construction costs, homebuilding costs, aluminum house framing, floor framing costs, wall framing costs, wood house framing.

CONTENTS

Page

HIGHLIGHTS........ x
COST OF WOOD AND ALUMINUM FLOOR FRAMING AT 1970 PRICES........ 1
  Wood Joist Construction........ 1
    Lumber and plywood quantities........ 1
    Lumber and plywood prices........ 1
    Labor quantities........ 3
    Labor wages........ 6
    Total in-place cost........ 7
  Aluminum Joist Construction........ 7
    Aluminum and plywood quantities........ 7
    Aluminum and plywood prices........ 7
    Labor quantities........ 9
    Labor wages........ 10
    Total in-place costs........ 10
COST OF WOOD AND ALUMINUM WALL FRAMING AT 1970 PRICES........ 11
  Wood Stud Construction........ 11
    Lumber quantities........ 11
    Lumber prices........ 13
    Labor quantities........ 13
    Labor wages........ 14
    Total in-place cost........ 14
  Aluminum Stud Construction........ 15
    Aluminum quantities........ 15
    Aluminum prices........ 19
    Labor quantities........ 19
    Labor wages........ 19
    Total in-place cost........ 20
COST OF WOOD AND ALUMINUM FLOOR FRAMING AT 1973 PRICES........ 23
  Wood Joist Construction........ 23
    Lumber and plywood quantities........ 23
    Lumber and plywood prices........ 24
    Labor quantities........ 24
    Labor wages........ 25
    Total in-place cost........ 26

CONTENTS--Continued

Page

Aluminum Joist Construction.. 26
    Aluminum and plywood quantities................................ 26
    Aluminum and plywood prices.................................... 26
    Labor quantities... 26
    Labor wages.. 26
    Total in-place cost.. 27
COST OF WOOD AND ALUMINUM WALL FRAMING AT 1973 PRICES............... 27
Wood Stud Construction... 27
    Lumber quantities.. 27
    Lumber prices.. 27
    Labor quantities... 30
    Labor wages.. 30
    Total in-place cost.. 31
Aluminum Stud Construction... 31
    Aluminum quantities.. 31
    Aluminum prices.. 31
    Labor quantities... 31
    Labor wages.. 31
    Total in-place cost.. 31
APPENDIX 38

LIST OF TABLES

Table No.		Page
1	Quantity of lumber required to frame floors	2
2	Range of estimated prices builders paid for No. 2 or better, S-Dry Douglas-fir, Douglas-fir-larch, Hem-fir, or Southern pine, 1970	3
3	Estimated prices builders paid for tongue and grooved-2E underlayment grade plywood with exterior type adhesive, 1970	4
4	Amount of labor required to frame floors, 1970	5
5	Amount of labor required to install single-layer, tongue and grooved plywood flooring, 1970	5
6	Wage rates including fringe benefits for wood floor and wall framing in residential construction, 1970	6
7	Material requirements for aluminum floor joists spaced 24 inches on center for three typical floor plans	8
8	Estimated unit-labor (standard man minutes per square foot of floor area), for on-site fabrication of aluminum residential floor framing, by house complexity	10
9	In-place costs, per square foot of floor area, for large builders in three metropolitan areas, for wood and aluminum framed floor systems, 1970	11
10	Quantity per linear foot of lumber typically used to frame non-load-bearing interior partitions and load-bearing exterior walls	13
11	Range of estimated prices builders paid for 2x3 and 2x4 stud grade wall framing in 1970. Price in parenthesis is for Southern pine, Wash., D.C.	14
12	Quantity of labor per linear foot of wall including window and door widths except where full ceiling height doors are used	15
13	Aluminum requirements for simple framed residence	16
14	Aluminum requirements for typical framed residence	17
15	Aluminum requirements for complex framed residence	18
16	Estimated unit-labor (standard man minutes per linear foot of wall area), for on-site fabrication of aluminum residential wall framing, by house complexity	19

LIST OF TABLES
(continued)

Table No.		Page
17	In-place costs, per linear foot of wall area, for large builders in three metropolitan areas, for wood and aluminum framed interior partitions, 1970	20
18	In-place costs, per linear foot of wall area, for large builders in three metropolitan areas, for wood and aluminum framed exterior walls, 1970	23
19	Estimated prices builders paid for No.2 or better S-Dry Douglas-fir, Douglas-fir-larch, Hem-fir, or Southern pine, 1973	24
20	Estimated prices builders paid for tongue and grooved-2E underlayment grade plywood with exterior type adhesive, 1973	25
21	Wage rates, including fringe benefits, for wood floor framing in residential construction, 1973 dollars	25
22	In-place costs, per square foot of floor area, for wood and aluminum framed floor systems, for large builders in three metropolitan areas, 1973	27
23	Estimated prices builders paid for 2x3 and 2x4 stud grade wall framing, 1973	30
24	Wage rates, including fringe benefits, for wood wall framing in residential construction, 1973 dollars	30
25	In-place costs, per linear foot of wall area, for wood and aluminum framed interior non-load partitions, for large builders in three metropolitan areas, 1973	32
26	In-place costs, per linear foot of wall area, for wood and aluminum framed exterior walls, for large builders in three metropolitan areas, 1973	34

LIST OF APPENDIX TABLES

Table No.		Page
1	In-place costs per square foot of constructing floors with wood framing and plywood flooring in Chicago,1970	39
2	In-place costs per square foot of constructing floors with wood framing and plywood flooring in Los Angeles 1970	40
3	In-place costs per square foot of constructing floors with wood framing and plywood flooring in Wash., D.C., 1970	41
4	In-place costs per square foot of constructing floors with aluminum framing and plywood flooring in three metropolitan areas, 1970	42
5	In-place costs per linear foot of wood nonload-bearing partitions framed with 2x3 studs in Chicago, 1970	43
6	In place costs per linear foot of wood nonload-bearing partitions framed with 2x3 in Los Angeles, 1970	44
7	In-place costs per linear foot of wood nonload-bearing partitions framed with 2x3 studs in Washington, D.C. 1970	45
8	In-place costs per linear foot for aluminum nonload-bearing partitions, in three metropolitan areas, 1970	46
9	In-place costs per linear foot of wood exterior load-bearing walls framed with 2x4 studs in Chicago, 1970	47
10	In-place costs per linear foot of wood exterior load-bearing walls framed with 2x4 studs in Los Angeles, 1970	48
11	In-place costs per linear foot of wood exterior load-bearing walls framed with 2x4 studs in Washington, D.C., 1970	49
12	In-place costs per linear foot of aluminum framing (2x4, 24 inches on center) for exterior load-bearing walls, in three metropolitan areas, 1970	50
13	In-place costs per square foot of constructing floors with wood framing and plywood flooring in Chicago, 1973	51
14	In-place costs per square foot of constructing floors with wood framing and plywood flooring in Los Angeles 1973	52

LIST OF APPENDIX TABLES
(continued)

Table No. Page

15 In-place costs per square foot of constructing floors with wood framing and plywood flooring in Washington, D.C., 1973 53

16 In-place costs per square foot of constructing floors with aluminum framing and plywood flooring in three metropolitan areas, 1973 54

17 In-place costs per linear foot of wood nonload-bearing partitions framed with 2x3 studs in Chicago 1973 55

18 In-place costs per linear foot of wood nonload-bearing partitions framed with 2x3 studs in Los Angeles, 1973 56

19 In-place costs per linear foot of wood nonload-bearing partitions framed with 2x3 studs in Washington, D.C. 1973 57

20 In-place costs per linear floor for aluminum nonload-bearing partitions, in three metropolitan areas, 1973 58

21 In-place costs per linear foot of wood exterior load-bearing walls framed with 2x4 studs in Chicago, 1973 59

22 In-place costs per linear foot of wood exterior load-bearing walls framed with 2x4 studs in Los Angeles, 1973 60

23 In-place costs per linear foot of wood exterior load-bearing walls framed with 2x4 studs in Washington, D.C., 1973 61

24 In-place costs per linear foot of aluminum framing (2x4, 24 inches on center) for exterior load-bearing walls, in three metropolitan areas, 1973 62

HIGHLIGHTS

During 1970, when the range of F.O.B. framing lumber prices did not fluctuate more than $13 per thousand board feet, lumber as a framing material for floors, interior partitions, and exterior walls maintained a distinct in-place cost advantage over aluminum framing.

However, during 1973, F.O.B. framing lumber prices ranged from a low of $126 per thousand board feet to a high of $201, a fluctuation of $75. The highest price occurred during a 3-week period, embracing the last 2 weeks of March and the first week of April. This period was chosen to demonstrate, by way of comparison, how the increased lumber prices would affect the comparative in-place costs for wood versus aluminum framing for residential floors, interior partitions, and exterior walls. Aluminum prices and lumber and plywood prices were then at their extreme, and this is not necessarily the normal price relationship. It does show the effect produced when these extreme price conditions existed. For example, since this report was written, aluminum prices have increased 10.6 percent above their quoted prices, and lumber prices have decreased 18 percent, and plywood prices have decreased 29 percent below the 1973 quoted price in the report. The reader should bear this in mind when comparing future price relationships between these two materials.

The cities of Chicago, Los Angeles, and Washington, D. C., were selected for use in this study as reasonably representative of the large metropolitan areas where most housing construction takes place in the United States.

Floor system: cost at 1970 prices

The most common type of wood floor framing system used 2x8 joists spaced 16 inches on center, while the typical aluminum framed floor system used 2x8 joists spaced 24 inches on center. The wood system used 5/8-inch plywood flooring, and the aluminum system 3/4-inch plywood flooring.

In-place costs paid by large builders varied slightly among the three cities in this study, but wood systems had a definite cost advantage over similar aluminum-framed systems.

For purposes of comparison in this section of the report, costs paid by large builders in the Los Angeles area were used as an example, because in-place costs there were found to be representative of the cities studied.

Typical in-place floor costs, in dollars per square foot, for a large volume builder in Los Angeles, were estimated as follows: 1/

	Total	Material	Labor
Aluminum floor system	0.623	0.551	0.072
Wood floor system	.483	.361	.122
Differential	.140		

Although material costs clearly dominate the in-place costs of both flooring systems, the wood system maintained a distinct cost advantage of 29 percent over the aluminum system for 1970.

Floor system: cost at 1973 prices

Between the two study periods, both labor and material prices increased. Labor rates for Los Angeles went from $0.1064 per man minute to $0.1336 per man minute, a 26-percent increase. Lumber prices for Los Angeles went from $0.192 per square foot of floor area to $0.377 per square foot, an increase of 96 percent. Five-eighths-inch plywood went from $0.169 per square foot of floor area, to $0.337 per square foot, an increase of 99 percent; while 3/4-inch plywood went from $0.211 per square foot of floor area, to $0.434 per square foot, an increase of 106 percent. Aluminum material prices went from $0.34 per square foot of floor area, to $0.36 per square foot, an increase of 6 percent. Typical in-place costs (in dollars per square foot) for a large volume builder in Los Angeles were estimated as follows:

	Total	Material	Labor
Aluminum floor system	0.885	0.794	0.091
Wood floor system	.867	.710	.157
Differential	.018		

Large increases in lumber and plywood prices (compared to the rather small increase in aluminum prices) occurred between the two study periods. This resulted in the wood floor system in-place cost per square foot approaching that for an aluminum floor system.

Interior partitions: cost at 1970 prices

Data for interior partition framing were collected for 2x3 and 2x4 studs, spaced both 16 and 24 inches on center for both wood and aluminum systems. 2/

1/ See appendix tables 1, 2, 3, and 4 for cost by type of floor, builder, material, and labor for Chicago, Los Angeles, and Washington, D. C.

2/ See appendix tables 5, 6, 7, and 8 for cost by type of partition, builder, material, and labor for Chicago, Los Angeles, and Washington, D. C.

In this study, only 2x3 studs spaced 24 inches on center were used for comparison. In-place costs, in dollars per linear foot of wall area for large builders in Los Angeles, were estimated as follows:

	Total	Material	Labor
Aluminum interior partition	1.691	1.148	0.543
Wood interior partition	1.021	.454	.567
Differential	.670		

Labor installation costs were nearly the same for both systems. However, the difference in material costs of $0.69 per linear foot gave wood a decided price advantage of 66 percent over aluminum.

Interior partitions cost at 1973 prices

From 1970 to 1973, labor rates increased 26 percent, 2x4 stud prices increased 112 percent, and aluminum increased 7 percent. In-place costs, in dollars per linear foot of wall area for large builders in Los Angeles, were estimated as follows: 3/

	Total	Material	Labor
Aluminum interior partition	1.929	1.232	0.697
Wood interior partition	1.690	.962	.728
Differential	.239		

Exterior wall: cost at 1970 prices

Information for framing exterior load-bearing walls was collected for 2x4 studs spaced 16 and 24 inches on center for wood, but only for 2X4 studs spaced 24 inches on center for aluminum. 4/

Comparisons made were based on wood exterior walls framed with 2x4 studs spaced 16 inches on center, and aluminum framed walls with 2x4 studs spaced 24 inches on center. In-place costs, in dollars per linear foot of wall area for large builders in Los Angeles, were estimated as follows:

	Total	Material	Labor
Aluminum exterior walls	2.242	1.476	0.766
Wood exterior walls	1.518	.848	.670
Differential	.724		

3/ See appendix tables 17, 18, 19, and 20 for cost by type of partition, builder, material, and labor for Chicago, Los Angeles, and Washington, D. C.

4/ See appendix tables 9, 10, 11, and 12 for cost by type of exterior wall, builder, material, and labor for Chicago, Los Angeles, and Washington, D. C.

Wood materials cost $0.63 per linear foot less than aluminum materials, giving wood a marked cost advantage over aluminum. The in-place cost differential of $0.72 per linear foot was the equivalent of a 48-percent cost advantage favoring wood.

Exterior wall: cost at 1973 prices

By 1973, rising lumber prices resulted in a cost advantage for aluminum in framed exterior walls. 5/

In-place costs, in dollars per linear foot of wall area for large builders in Los Angeles, were estimated as follows:

	Total	Material	Labor
Wood exterior walls	2.659	1.798	0.861
Aluminum exterior walls	2.568	1.584	.984
Differential	.091		

Aluminum's cost advantage of $0.09 per linear foot over wood-framed exterior walls translated into a 4-percent cost margin.

5/ See appendix tables 21, 22, 23, and 24 for cost by type of exterior wall, builder, material, and labor for Chicago, Los Angeles, and Washington, D. C.

COST OF WOOD AND ALUMINUM FLOOR FRAMING AT 1970 PRICES

About two-thirds of all housing is built in large metropolitan areas. This analysis compares in-place costs of floors framed with wood and aluminum in single-family, site-built homes in Chicago, Los Angeles, and Washington, D. C. in 1970. These cities were selected because they were located within the largest metropolitan regions where most new house construction occurs.

Estimates of costs include the installed cost of single-layer plywood flooring as well as installed cost of lumber and aluminum framing. Typical structural lumber species (Douglas-fir, Douglas-fir-larch, Hem-fir, and Southern pine), grades (No. 2 and Better and Utility or No. 3),and sizes (2x8 and 2x10) used by builders were studied.

WOOD JOIST CONSTRUCTION

Lumber and plywood quantities

Amounts of wood framing used in floors vary considerably depending on joist size and spacing, the complexity of the framing system (stairwells, openings, chimneys, and other irregularities), the amount of special framing or blocking required by building codes, and the efficiency of the builder. Table 1 summarizes the range of quantities of lumber required for framing typical floors. The data selected from this table were used in data compilations in both study periods (1970 and 1973).

Research findings from several studies[6/] indicate that plywood requirements will range between 1.06 and 1.08 square feet per square foot of floor area. The lesser amount applies to houses with modular dimensions, no openings in the floor, and no waste scrap. For this study, a value of 1.06 square feet of plywood per square foot of floor area was used. This figure was used in data compilations in both study periods (1970 and 1973) reported on.

Lumber and plywood prices

The major (but not necessarily all) factors that influence the builder's price paid for lumber and plywood are: species, grade, location, supply source, volume of purchase, transportation costs, local pricing, methods of distribution (tables 2 and 3). An attempt was made to take these factors into account in arriving at the estimated builder prices used in this study.

[6/] Koenigshof, Gerald A., Comparative in-place cost between wood and steel residential floor and wall framing, Research paper WO-22, June 1974.

Table 1.--Quantity of lumber required to frame floors

Nominal joist size	Spacing o.c.	Typical lumber grade	Lumber required per square foot of floor 1/		
			Simple framing with well-planned usage of material	Amount in a typical house	Complex framing without well-planned usage of material
	Inches		Board feet		
2X8	16	No. 2 and better, Douglas-fir or Southern pine	1.45	1.55	1.65
2X8	16	No. 3 Hem-fir	1.50	1.70	1.90
2X10	16	No. 2 and better Douglas-fir or Southern pine	1.55	1.85	2.05
2X10	16	No. 3 Hem-fir and better	1.85	2.15	2.45
2X10	24	No. 3 and better Douglas fir, Hem-fir, Southern pine	1.15	1.25	1.35

1/ Area of openings in floors such as stairwells is not included when computing the board foot per square foot of floor.

Source: Comparative in-place cost between wood and steel residential floor and wall framing, by G. A. Koenigshof, Research paper WO-22, June 1974.

Table 2.--Range of estimated prices builders paid for No. 2 or better, S-Dry Douglas-fir, Douglas-fir-larch, Hem-fir, or Southern pine, 1970

(Dollars per thousand board feet)

Nominal size	Area	Large volume purchase direct from mills			Large volume purchase from retail yard			Small volume purchase from retail yard		
		Low	Mid	High	Low	Mid	High	Low	Mid	High
2X8	Chicago	127	137	147	133	143	154	144	156	167
	Los Angeles	116	124	133	121	129	139	132	141	151
	Wash., D.C.	117	133	149	122	139	155	133	151	169
2X10	Chicago	136	148	160	142	155	167	155	168	182
	Los Angeles	121	133	146	126	139	153	137	151	166
	Wash., D.C.	126	144	162	132	151	169	143	164	184

Source: Comparative in-place cost between wood and steel residential floor and wall framing, Research Paper WO-22, June 1974.

Labor quantities

Labor requirements for installing wood floors vary widely, largely based on methods and equipment, size of crew, skill levels, quality of supervision, weather, and other factors. Some workmen are fast and efficient while others are not.

Industrial engineers use a technique called "effort rating" that adjusts actual measured time to account for variations between workmen. In addition, allowances are made for fatigue, unavoidable delays, personal time, resting, and the like. Actual field measured time, with the above adjustment and allowances, is called "standard time." Estimated labor requirements for installing floor framing shown in table 4 are in standard time. These estimates indicated that it takes about two-thirds as much time to frame a floor with 24 inch joist spacing as it does with 16-inch joist spacing. These labor estimates were used in data compilations in both study periods (1970 and 1973) reported on.

Table 3.--Estimated prices builders paid for tongue and grooved-2E underlayment grade plywood with exterior type adhesive, 1970

(Dollars per thousand square feet)

Thickness (inches)	Area	Large volume purchase direct from mill	Large volume purchase from retail yard	Small volume purchase from retail yard
5/8	Chicago	167	175	190
	Los Angeles	159	166	180
	Washington, D.C.	172	180	195
3/4	Chicago	191	200	217
	Los Angeles	180	188	205
	Washington, D.C.	197	206	224
1 1/8	Chicago	303	317	345
	Los Angeles	287	300	326
	Washington, D.C.	312	326	354

Source: Comparative in-place cost between wood and steel residential floor and wall framing, Research Paper WO-22 June 1974.

Relatively little information is available concerning the amount of labor required to lay plywood floors on wood joists spaced 24 and 48 inches apart. However, there is considerable data relating to 16-inch spacing. It was therefore possible to develop what appears to be reasonable installation cost estimates for single-layer plywood floors (tongue and grooved) on joists of 24-and 48-inch spacing. These estimates are presented in table 5 and were used in data compilations in both 1970 and 1973 study periods.

Table 4.--Amount of labor required to frame floors, 1970

Nominal Joist Size	Spacing o.c.	Labor required per square foot of floor area: Simple framing with well-planned usage of material	Amount in typical house	Complex framing without well-planned usage of material
	Inches	Standard man-minutes		
2X8	16	0.40	0.70	1.30
2X8	24	.30	.50	.75
2X10	16	.45	.75	1.35
2X10	24	.35	.55	.80

Source: Comparative in-place cost between wood and steel residential floor and wall framing, Research Paper WO-22, June 1974.

Table 5.--Amount of labor required to install single layer, tongue and grooved plywood flooring, 1970

Spacing of floor joist	Labor required per square foot of floor area: Simple framing with well-planned usage of material	Amount in typical house	Complex framing without well-planned usage of material
Inches	Standard man-minutes		
16	0.28	0.45	0.62
24	.25	.35	.45
48	.18	.26	.34

Source: Comparative in-place cost between wood and steel residential floor and wall framing, Research Paper WO-22, June 1974.

Labor wages

Both carpenter and laborer wage data are the union wage rates for the cities in this study as published in "News," by the U.S. Department of Labor, Bureau of Labor Statistics. However, in Washington, D.C., much of the single-family housing is built by non-union labor. Actual labor costs in that area were lower than the union rates used in this study.

In previous cost studies, wage rates were supplied by the National Association of Home Builders, who reported actual wage rates most commonly used in each single-family housing construction area. With the establishment of the Construction Industry Stabilization Committee in March 1971, NAHB discontinued reporting actual wage rates for various single-family construction areas.

The mix of skill levels is not well defined. In this study it was assumed that half the labor required to frame floors, as well as wall areas, was performed by carpenters and half by laborers. The wage rates, found in table 6, were used in computing the in-place, estimated costs for all floor and wall framing for the study year 1970.

Table 6.--Wage rates including fringe benefits for wood floor and wall framing in residential construction, 1970

(Dollars)

Area	Carpenter wages		Laborer wages	
	Per hour	Per minute	Per hour	Per minute
Chicago	7.04	0.1173	5.67	0.0945
Los Angeles	7.47	.1245	5.30	.0883
Washington, D.C.	6.17	.1028	4.54	.0757

Source: U.S. Department of Labor, Bureau of Labor Statistics

Total in-place cost

Appendix tables 1, 2, and 3 summarize cost calculations for installation of floors supported by wood joists. The tables include two sizes of framing materials commonly used in flooring systems: (1) Where 2x8's are spaced 16 inches on center sheathed with 5/8 inch plywood, and (2) where 2X10's are spaced 24 inches on center, sheathed with 3/4 inch plywood. For each of the three selected cities, three cost estimates are shown:

1. A large volume builder purchasing lumber directly from a sawmill
2. A large volume builder purchasing lumber from a retail yard
3. A small volume builder purchasing lumber from a retail yard.

The estimated, in-place costs for these different situations ranged from $0.45 to $0.56 per square foot of floor area framed. These estimates were based on average labor and material prices. Because prices vary considerably from the average, actual cost in any area may vary substantially from these average values.

ALUMINUM JOIST CONSTRUCTION

Aluminum and plywood quantities

At present, there is no active market for aluminum floor framing members. Floor plans with typical dimensions and characteristics of wood floors were framed with aluminum. Material quantities were calculated for each floor system. The weight of the floor system was found by adding the weights of the individual parts of the system. The NAHB Research Foundation, Inc., verified the amounts of aluminum required to frame floors in a report 7/ based on actual field studies where aluminum framing was used.

Table 7 shows the range of quantities of aluminum required for floor framing which were used in the data compilation in both study periods (1970 and 1973) reported here.

The amount of 3/4-inch plywood used was 1.06 square feet per square foot of floor area. The type of plywood used for estimating in this study was Standard Western, Sheathing grade, with exterior glue, and tongue and grooved two edges. The plywood was glued and nailed to the aluminum joists. The cost of gluing and nailing plywood to joists was included in the total in-place cost for aluminum floor framing.

Aluminum and plywood prices

Aluminum prices were taken from weekly quotations for Extrusions, 6061-T6 solids in "American Metal Market," a daily publication of Fairchild Publications, Inc., New York, New York. Average 1970 prices for standard minimum quantities delivered to customer plant were used in this study.

7/ Material and Labor Requirements for Aluminum Framed Residential Construction by NAHB Research Foundation, Inc., June 1973, 15 p.

Table 7.--Material requirements for aluminum floor joists spaced 24 inches on center for three typical floor plans

Construction item	Linear feet	Pounds per foot	Total pounds	Pounds per square foot
Simple floor framing--1008 sq. ft.				
Plate, 8-inch	130	1.438	187	
Joist, 2X8	476	1.177	560	
Joist cripple, 8-inch	20	.551	11	
Total pounds			758	0.75
Typical floor framing--1,088 sq. ft.				
Plate, 8-inch	152	1.438	219	
Joist, 2X8	560	1.177	659	
Joist cripple, 8-inch	24	.551	13	
Total pounds			891	.82
Complex floor framing--1,354 sq. ft.				
Plate, 8-inch	210	1.438	302	
Joist, 2X8	766	1.177	902	
Joist cripple, 8-inch	10	.551	6	
Total pounds			1,210	.89

Sources: USDA Forest Service and NAHB Research Foundation, Inc.

Large volume builders purchasing such structural members as floor joists and wall studs were assumed to pay 15 percent less than the quoted price for Extrusions, 6061-T6 solids. Their cost would be 41 cents per pound (see tabulation, below). This method was used because it reflected actual prices large volume builders were paying for aluminum framing in the field studies made by NAHB Research Foundation, Inc.

In the case of the small builder, it would be necessary for shipment to be made through a dealer. The dealer was assumed to pay approximately the same price for aluminum as that paid by large volume builders. A dealer mark-up was estimated to be 25 percent, making the cost of aluminum to the small builder 51 cents per pound, as the following tabulation shows:

	Cents per pound
1970 average aluminum delivered price per pound	48.
Less 15 percent discount	7.
Price per pound paid by large volume builders	41.
1970 average aluminum delivered price per pound	48.
Less 15 percent discount	7.
Price per pound paid by dealer	41.
Plus 25 percent mark-up	10.
Price per pound paid by small volume builders	51.

The above per pound aluminum prices were used to compute material costs for all aluminum framing members used in the 1970 portion of this study.

Labor quantities

Relatively little information is available on labor requirements for installing aluminum floor framing. Labor quantities are substantially less than those for setting wood floor joists. Aluminum joists weigh less than wood joists which makes it easier to handle and install aluminum floor framing. This is especially true for large joists used on long spans. Table 8 contains the estimated labor requirements for setting floor joists. The labor quantities in table 8, for a typical house, were used in data compilations in both study periods.

The labor requirements for installation of plywood over aluminum joists spaced 24 inches on center were estimated to be the same as those for placing plywood over wood joists with the same spacing. This figure is 0.35 standard man minutes per square foot (SMM/SF) (table 5), plus 0.07 SMM/SF (the estimated labor required to glue and nail plywood to aluminum joists) which totals 0.42 SMM/SF. These plywood labor requirements were used in data computations in both the 1970 and 1973 study periods.

Labor wages

Currently aluminum floors are installed by carpentry crews that frame other parts of the house. Wages paid to carpenters and laborers for installing aluminum floors were therefore assumed to be the same as those for installing wood floors, table 6.

Total in-place costs

Appendix table 4 summarizes cost calculation for installation of floors supported by aluminum joists. For each of the three selected cities, two cost estimates are shown:

1. A large volume builder purchasing aluminum directly from the mill.
2. A small volume builder purchasing aluminum from a retail outlet.

The estimated, in-place costs for these different situations ranged from $0.62 to $0.72 per square foot of floor area framed. In-place cost differentials between large builders who used 2X8 aluminum joists spaced 24 inches on center, and large builders who used 2X8 wood joists spaced 16 inches on center are shown in table 9.

Table 8.--Estimated unit-labor (standard man minutes per square foot of floor area), for on-site fabrication of aluminum residential floor framing, by house complexity

Item	Type of Framing		
	Simple	Typical	Complex
2X8 joist spaced 24 inches on center	-----Standard man minutes/square foot. . .		
	0.15	0.25	0.35

Sources: USDA Forest Service and NAHB Research Foundation, Inc. Material and labor requirements for aluminum framed residential construction, June 1973, 15 p.

Table 9.--In-place costs, per square foot of floor area, for large builders in three metropolitan areas, for wood and aluminum framed floor systems, 1970

Area	Floor system		Difference	
	Aluminum 1/	Wood 2/		
	$/S.F.	$/S.F.	$/S.F.	Percent
Chicago	0.63	0.51	0.12	24
Los Angeles	.62	.48	.14	29
Washington, D.C.	.63	.49	.14	29

1/ 2X8 joists spaced 24 inches on center
2/ 2X8 joists spaced 16 inches on center

COST OF WOOD AND ALUMINUM WALL FRAMING AT 1970 PRICES

This analysis compares in-place costs of wood and aluminum framing in single-family, site-built homes in Chicago, Los Angeles, and Washington, D.C., in 1970, and factors influencing these costs. Costs of wall facings(wallboard and other materials) are not included since costs of these items are virtually the same for wood and aluminum. Linear footage of walls is defined to include window and door opening widths, except where full ceiling height doors are used.

WOOD STUD CONSTRUCTION

Lumber quantities

The amount of lumber used to frame both non-load-bearing and load-bearing walls varies considerably according to stud size (usually 2X3 or 2X4); stud spacing (usually 16 or 24 inches); number and size of door, window and other openings, framing and blocking used, and efficiency in use of materials.

The range of lumber used per linear foot of non-load-bearing walls was 3.85 to 7.68 board feet (table 10). The range of use for load-bearing walls was 6.33 to 10.12 board feet per linear foot (table 10). These board foot figures are representative of the lumber quantities for typical house framing for non-load-bearing walls and load-bearing walls in single-family construction, and were used in data compilations in both 1970 and 1973 study periods.

The data shown on the figure below, as well as on all of the other figures appearing in the text, are the in-place costs for large builders in Los Angeles. Los Angeles was chosen as being reasonably representative of the cities in the study.

Figure 1 shows the in-place cost for floor framing for aluminum versus wood for the year 1970.

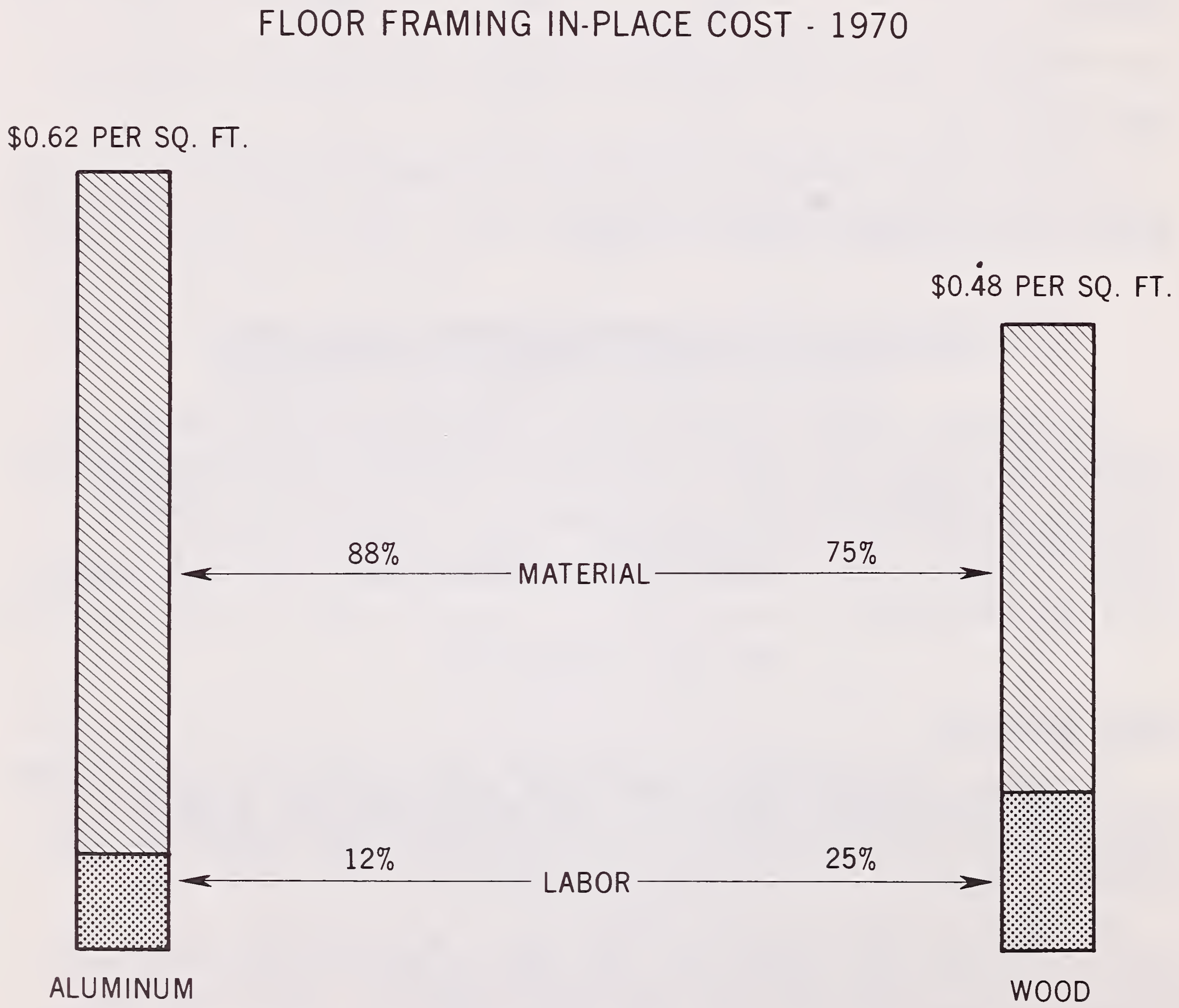


Figure 1.--Aluminum and wood floor framing in-place cost at 1970 prices.

Table 10.--Quantity per linear foot of lumber typically used to frame non-load-bearing interior partitions and load-bearing exterior walls

Non-Load-Bearing Partitions

Nominal stud size	Stud spacing in inches	Simple framing with well planned usage of material	Amount in typical house	Complex framing without well planned usage of material
		Board feet	Board feet	Board feet
2X3	16	4.32	5.04	5.76
2X3	24	3.85	4.54	5.23
2X4	16	5.76	6.72	7.68
2X4	24	5.18	6.11	7.03
		Load Bearing Exterior Walls		
2X4	16	6.84	8.48	10.12
2X4	24	6.33	7.65	8.96

Source: Comparative in-place cost between wood and steel residential floor and wall framing, Research Paper WO-22, June 1974.

Lumber prices

The lumber prices for 2X3 and 2X4 studs used for wall framing, for the year 1970, are given in table 11. The price for 2X3 studs was essentially the same as that for 2X4 studs. This was the conclusion of research after contacting a number of the largest wholesale and marketing firms.

Labor quantities

The labor requirements for framing wood walls vary widely depending upon type of construction, labor efficiency, and spacing of members. There is a slight difference in the amount of labor required to install 2X3 studs in a wall versus 2X4 studs. Table 12 takes this and other factors into consideration.

The labor quantities, per linear foot, for interior partitions and exterior walls in table 12, were used in data compilations in both periods reported on in this study.

Table 11.--Range of estimated prices builders paid for 2X3 and 2X4 stud grade wall framing in 1970. Price in parenthesis is for southern pine in Washington, D.C.

Area	Large volume purchased direct from mill	Large volume purchased from retail yard	Small volume purchased from retail yard
	Dollars per thousand board feet		
Chicago	114	119	129
Los Angeles	100	105	114
Washington, D.C.	117 (100)	122 (105)	133 (114)

Source: Comparative in-place cost between wood and steel residential floor and wall framing, Research Paper WO-22, June 1974.

Labor wages

The wage rates for installing interior partitions and exterior walls are shown in table 6.

Total in-place cost

Appendix tables 5, 6, and 7 present the in-place cost estimates for the framing of non-load-bearing partitions, and appendix tables 9, 10 and 11 contain in-place estimates for load bearing walls for the selected cities in this study. Estimates took into account stud size and stud spacing for each city using their respective wage rates. Also taken into consideration were three different types of builders, according to their purchasing methods.

1. Large volume builder purchasing lumber directly from a sawmill.
2. Large volume builder purchasing lumber from a retail yard.
3. Small volume builder purchasing lumber from a retail yard.

In-place costs, in dollars per linear foot in 1970, ranged between $1.01 and $1.31 for non-load-bearing partitions, and between $1.40 and $1.76 for load-bearing exterior walls.

Table 12.--Quantity of labor per linear foot of wall including window and door widths except where full ceiling height doors are used

Non-Load-Bearing Partitions

Nominal stud size	Stud spacing in inches	Simple framing with well planned usage of material	Amount in typical house	Complex framing without well planned usage of material
		...........Man minutes per linear foot...........		
2X3	16	4.46	6.20	7.94
2X4	16	4.69	6.51	8.33
2X3	24	4.00	5.33	6.66
2X4	24	4.20	5.60	7.00
Load-Bearing Exterior Walls				
2X4	16	4.54	6.30	8.06
2X4	24	4.31	5.98	7.47

Source: Comparative in-place cost between wood and steel residential floor and wall framing, Research Paper WO-22, June 1974.

ALUMINUM STUD CONSTRUCTION

Aluminum quantities

At the time this report was written there was no active market for aluminum wall framing members used in residential construction. Interior partition and exterior wall areas contained in houses with typical dimensions and characteristics, were framed with aluminum. The weight of each system was determined by adding the weights of the individual parts of each system. The NAHB Research Foundation, Inc., verified the amounts of aluminum required to frame interior partitions and exterior walls in a report 8/ based on actual field studies where aluminum framing was used.

Tables 13, 14, and 15 present aluminum requirements for 2X3 and 2X4 aluminum studs, spaced 24 inches on center, per linear foot of wall area used in non-load bearing partitions, and requirements for 2X4 studs spaced 24 inches on center used in exterior walls.

8/ Material and labor requirements for aluminum framed residential construction by NAHB Research Foundation, Inc. June 1973,15 p.

Table 13.--Aluminum Requirements for Simple Framed Residence
(Pounds per linear foot) 1/

Item	Linear feet	Pounds per linear ft.	Total pounds	Pounds per linear ft.
EXTERIOR WALL FRAMING				
7 feet 9 inch stud, 2x4	599	0.397	238	
Cripple & headers, 2X4	68	0.397	27	
Plates, top & bottom 2X4	367	0.373	137	
Window jambs, 2X4	109	1.027	112	
Head plates, 2X4	26	1.103	29	
Sills, 2X4	26	0.989	26	
Jamb stud, 2X4 exterior	62	0.798	50	
Head plates, 2X4 exterior	9	0.911	8	
Threshold, 2X4 exterior	9	1.327	12	
Total pounds aluminum(188 LF)			639	3.40
INTERIOR WALL FRAMING -2x4				
7 feet 9 inch stud, 2X4	483	0.397	192	
Cripples, 2X4	4	0.397	2	
Plates, top & bottom, 4 inches	223	0.373	83	
Jamb stud, 2X4 interior	78	0.756	62	
Head plates, 2X4 interior	10	0.856	9	
Total pounds aluminum (116 LF)			348	3.00
INTERIOR WALL FRAMING -2x3				
7 feet 9 inch T-stud, 2X3	140	0.419	59	
7 feet 9 inch stud, 2X3	316	0.373	118	
Cripples, 2X3	4	0.373	2	
Plates, top & bottom, 3 inches	223	0.294	66	
Jamb stud, 2X3 interior	78	0.632	49	
Head plates, 2X3 interior	10	0.773	8	
Total pounds aluminum (116 LF)			302	2.60

Sources: USDA Forest Service and NAHB Research Foundation, Inc.

1/ Linear measurements include door and window openings, excluding ceiling-height openings.

Table 14.--Aluminum Requirements for Typical Framed Residence

Item	Linear feet	Pounds per linear foot	Total pounds	Pounds per linear foot
EXTERIOR WALL FRAMING				
7 feet 9 inch stud, 2X4	831	0.397	330	
Cripple & headers, 2X4	46	0.397	18	
Plates, top & bottom 2X4	440	0.373	164	
Window jambs, 2X4	135	1.027	139	
Sills, 2X4	31	0.989	31	
Door jambs, 2X4 exterior	32	0.798	26	
Head plates, 2X4 exterior	6	0.911	6	
Threshold, 2X4 exterior	6	1.327	8	
Head plates, 2X4	31	1.103	34	
Total pounds aluminum (210 LF)			756	3.60
INTERIOR WALL FRAMING-2x4				
7 feet 9 inch stud, 2X4	854	0.397	339	
Cripples, 2X4	3	0.397	1	
Plates, top & bottom, 4 inches	315	0.373	117	
Jamb stud, 2X4 interior	78	0.756	62	
Head plates, 2X4 interior	13	0.856	12	
Total pounds aluminum (166 LF)			531	3.20
INTERIOR WALL FRAMING-2x3				
7 feet 9 inch T-stud, 2X3	62	0.419	26	
7 feet 9 inch stud, 2X3	767	0.373	286	
Cripples, 2X3	3	0.373	1	
Plates, top & bottom, 3 inches	315	0.294	93	
Jamb stud, 2X3	78	0.632	49	
Head plates, 2X3	13	0.773	10	
Total pounds aluminum (166 LF)			465	2.80

Sources: USDA Forest Service and NAHB Research Foundation, Inc.

Table 15.--Aluminum Requirements for Complex Framed Residence

Item	Linear feet	Pounds per linear foot	Total pounds	Pounds per linear foot
EXTERIOR WALL FRAMING				
7 feet 9 inch stud, 2X4	400	0.397	159	
Cripples & headers, 2X4	76	0.397	30	
Plates, top & bottom, 2X4	303	0.373	113	
Window jambs, 2X4	171	1.027	176	
Head Plates, 2X4	52	1.103	57	
Sills, 2X4	52	0.989	51	
Door jambs, 2X4	47	0.798	38	
Head plates, 2X4	6	0.911	6	
Threshold	6	1.327	8	
Total pounds aluminum (168 LF)			638	3.80
INTERIOR WALL FRAMING -2x4				
7 feet 9 inch stud, 2X4	668	0.397	265	
Cripples 2X4	14	0.397	6	
Plates, top & bottom, 2X4	300	0.373	112	
Jamb stud, 2X4 interior	124	0.756	99	
Head plates, 2X4 interior	20	0.856	18	
Total pounds aluminum (147 LF)			500	3.40
INTERIOR WALL FRAMING -2x3				
7 feet 9 inch T-stud, 2X3	39	0.419	16	
7 feet 9 inch, 2X3	619	0.373	231	
Cripples, 2X3	14	0.373	5	
Plates, top & bottom, 3 inches	299	0.294	88	
Jamb stud, 2X3	134	0.632	85	
Head plates, 2X3	20	0.773	16	
Total pounds aluminum (147 LF)			441	3.00

Sources: USDA Forest Service and NAHB Research Foundation, Inc.

For purposes of this study, aluminum requirements for the so called "typical" house were used in estimating housing needs, and also for the 1973 portion of the study.

Aluminum prices

Aluminum stud prices per pound were the same as those used for floor joists.

Labor quantities

There is only a limited amount of information available on the amount of labor required to assemble and erect interior or exterior aluminum framed walls. For this study, the labor quantities for wall framing were determined to be slightly less than those used for wood framing, and are shown in table 16.

These quantities of aluminum per linear foot for interior partitions and exterior walls were used for both study periods, 1970 and 1973.

Labor wages

Studs are usually erected by carpenters or drywall crews. Wage rates used for estimating aluminum framing costs were the same as those used to erect wood stud walls, and are found in table 6.

Table 16.--Estimated unit-labor (standard man minutes per linear foot of wall area), for on-site fabrication of aluminum residential wall framing, by house complexity

Item	Type of Framing		
	Simple	Typical	Complex
	..Standard man minutes per linear foot....		
Exterior wall framing, 2X4 studs, 24 inches on center, including aluminum plates	5.90	7.20	8.50
Interior partitions			
2X4 studs, 24 inches on center, including aluminum plates	4.70	5.10	5.50
2X3 studs, 24 inches on center, including aluminum plates	4.70	5.10	5.50

Sources: USDA Forest Service and NAHB Research Foundation, Inc.

Total in-place cost

Appendix tables 8 and 12 present the estimated, in-place costs of aluminum wall framing for each of the three selected cities. In this study, only two builder-types were chosen for developing in-place costs:

1. Large volume builders who purchase directly from the prefabricator.
2. Small volume builders who purchase from retail outlets.

The range of in-place cost estimates for both 2X3 and 2X4 aluminum studs spaced 24 inches on center for interior partitions was $1.60 to $2.17 per linear foot of wall area framed. However, for purposes of comparing wood and aluminum framing, 2X3 studs, spaced 24 inches on center were used, as they were the most typical type found in residential interior partitioning. Table 17 and figure 2 compare estimated costs for large builders.

The range of in-place cost estimates for exterior wall framing was $2.12 to $2.60 per linear foot for the cities in this study. However, as a basis of comparison of the most commonly framed wood and aluminum exterior walls, wood studs spaced 16 inches on center were compared with aluminum studs spaced 24 inches on center. The results for large builders are shown in table 18 and figure 3.

Table 17.--In-place costs, per linear foot of wall area, for large builders in three metropolitan areas, for wood and aluminum framed interior partitions, 1970

Area	Wall system		Difference	
	Aluminum 1/	Wood 2/		
	$/L.F.	$/L.F.	$/L.F.	Percent
Chicago	1.69	1.08	0.61	56
Los Angeles	1.69	1.02	.67	66
Washington, D.C.	1.60	1.01	.59	58

1/ 2X3 aluminum studs, spaced 24 inches on center
2/ 2X3 wood studs, spaced 24 inches on center

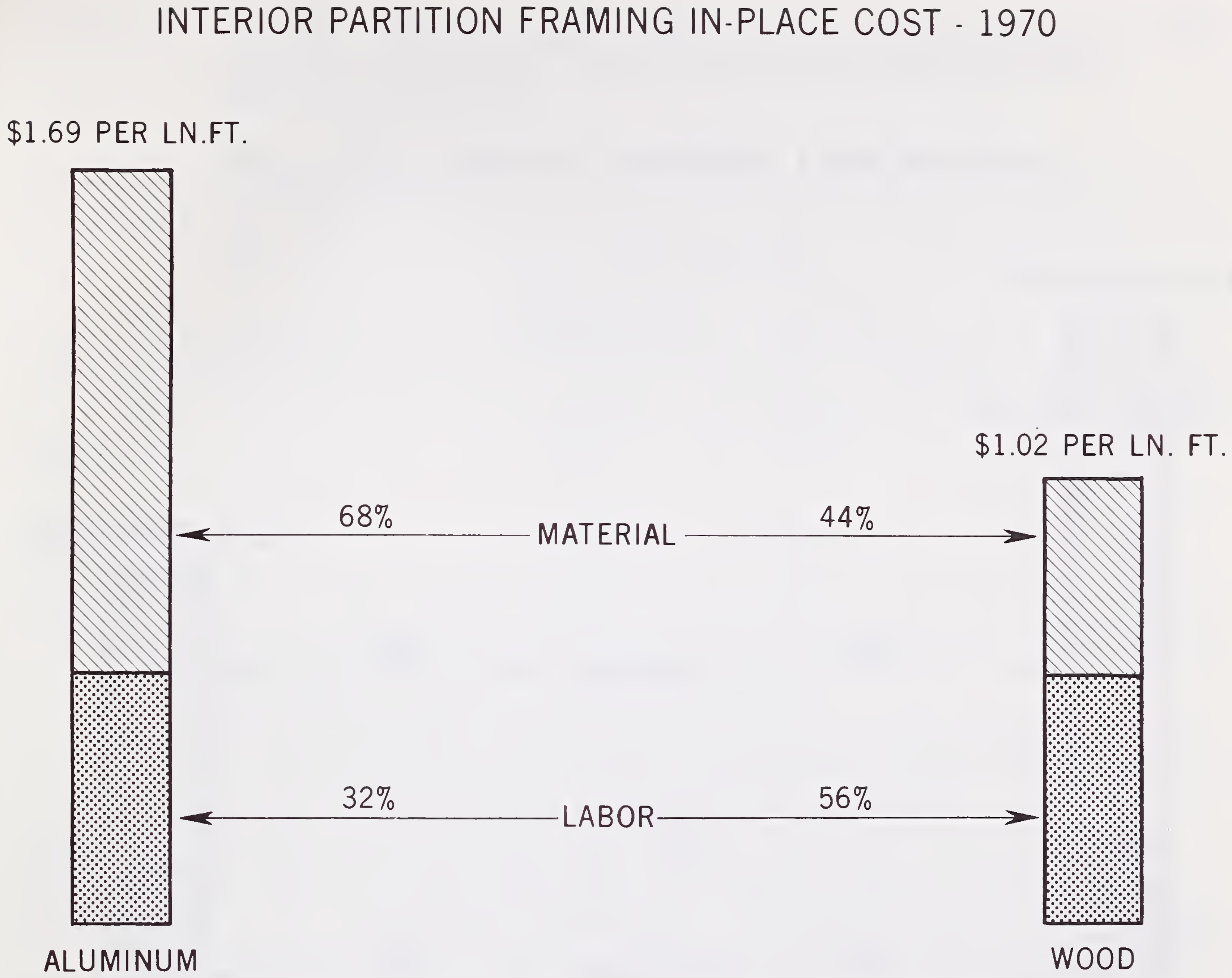


Figure 2.--Aluminum and wood interior partition framing in-place cost at 1970 prices.

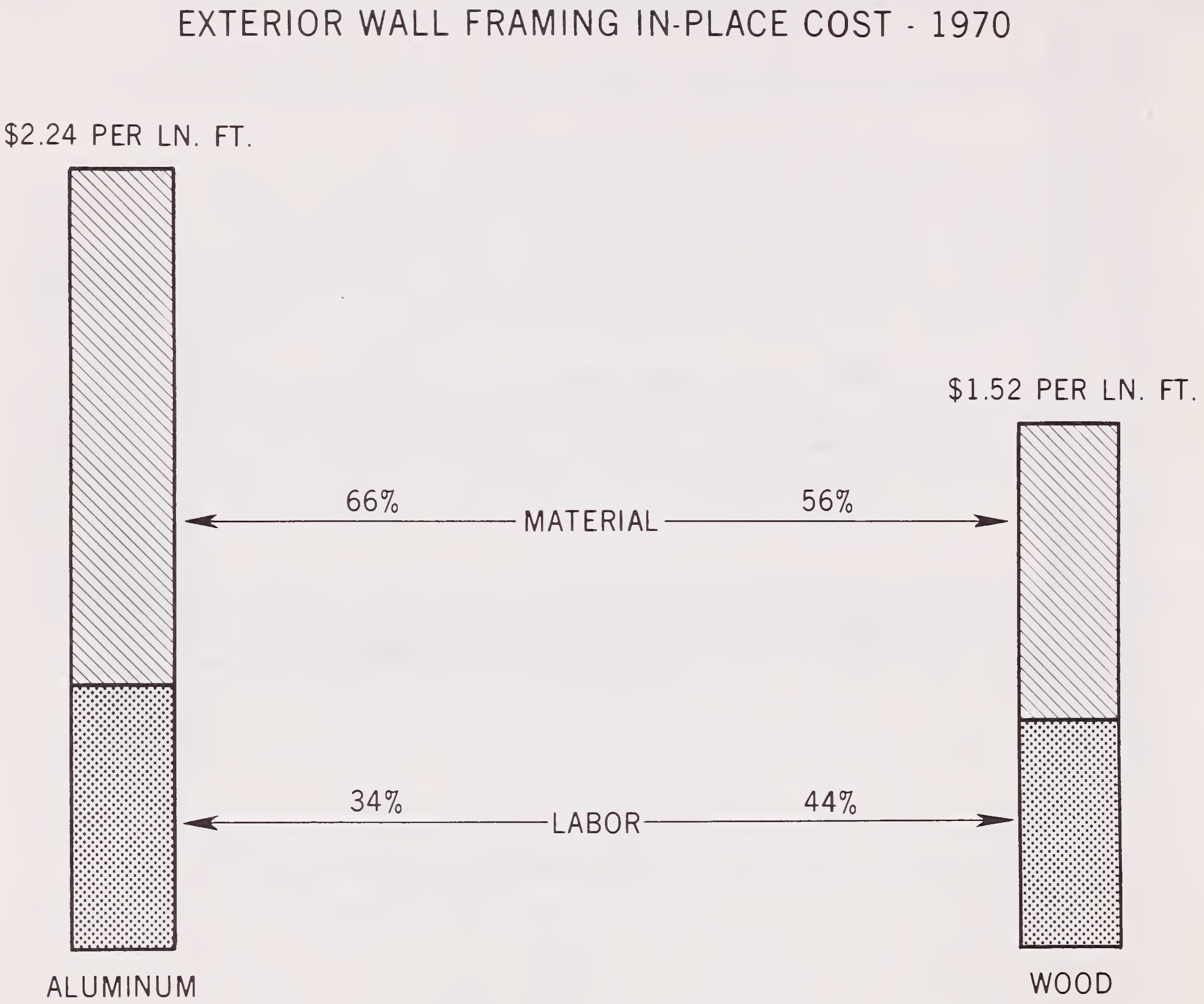


Figure 3.--Aluminum and wood exterior wall framing in-place cost at 1970 prices.

Table 18.--In-place costs, per linear foot of wall area, for large builders in three metropolitan areas, for wood and aluminum framed exterior walls, 1970

Area	Wall system		Difference	
	Aluminum 1/	Wood 2/		
	$/L.F.	$/L.F.	$/L.F.	Percent
Chicago	2.24	1.63	0.61	37
Los Angeles	2.24	1.52	.72	47
Washington, D.C.	2.12	1.55	.57	37

1/ 2X4 aluminum studs, spaced 24 inches on center
2/ 2X4 wood studs, spaced 16 inches on center

COST OF WOOD AND ALUMINUM FLOOR FRAMING AT 1973 PRICES

During the last weeks of March through the first week in April 1973, lumber and plywood prices reached their highest level for the year. This period was selected for comparison with 1970 in-place prices to show the effect of high lumber and plywood prices upon the in-place framing costs for floors and walls in residential construction. Aluminum prices used were those for the first quarter of 1973, and labor rates were the union rates for the first quarter of 1973 for the three cities selected.

Prices for labor and materials increased sharply between 1970 and 1973. For the large builder in the Los Angeles area, 2X8's went from $124.00 to $243.00 per thousand board feet; 5/8-inch plywood from $159.00 to $314.00 per thousand square feet; 3/4-inch plywood from $180.00 to $390.00 per thousand square feet; 2X3's and 2X4's went from $100.00 to $212.00 per thousand board feet. For the same builder, carpenter wages went from $7.47 to $8.89 per hour, and laborer's wages from $5.30 to $7.50 per hour. Aluminum prices went from 41 cents to 44 cents per pound for the same type builder.

WOOD JOIST CONSTRUCTION

Lumber and plywood quantities

The lumber and plywood quantities used were the same as those used in the 1970 section of this study; 1.55 board feet of 2X8, spaced 16-inches on center, for each square foot of floored area, and 1.06 square feet of 5/8-inch plywood, for each square foot of floored area.

579-419 O - 75 - 5

Lumber and plywood prices

Lumber prices paid by builders for 2X8's and 2X10's were estimated by the same method as was used in the first part of this study. However, in lieu of using the average price for the year (as was done for 1970), the highest weekly price was selected from the publication, Random Lengths, for the year 1973, and adjusted to reflect the respective freight rates to the individual cities, as well as the discounts allowed to the builders, according to their volume of purchases. The results are shown in table 19.

Plywood prices 5/8 inch and 3/4 inch paid by builders were estimated using the same procedure as that described below for lumber. The highest prices estimated to have been paid for plywood by builders during the year 1973, are shown by the type of volume purchase in table 20.

Labor quantities

The labor quantities used in this part of the study are the same as those used for the year 1970: labor quantities for installation of 2X8 floor joist, 16 inches on center, 0.70 SMM/S.F., and labor quantities for laying plywood over joists, 16 inches on center, 0.45 SMM/S.F. (tables 4 and 5).

Table 19.--Estimated prices builders paid for No. 2 or better, S-Dry Douglas-fir, Douglas-fir-larch, Hem-fir, or Southern pine, 1973

(Dollars per million board feet)

Nominal size	Area	Large volume purchase direct from mill	Large volume purchase from retail yard	Small volume purchase from retail yard
2X8	Chicago	255	266	290
	Los Angeles	243	254	276
	Wash., D.C.	257	269	292
2X10	Chicago	267	279	303
	Los Angeles	255	267	290
	Wash., D.C.	269	282	306

Sources: USDA Forest Service, Random Lengths Publications, Inc., Western Wood Products Association

Table 20.--Estimated prices builders paid for tongue and grooved-2E underlayment grade plywood with exterior type adhesive, 1973

(Dollars per thousand square feet)

Thickness	Area	Large volume purchase direct from mill	Large volume purchase from retail yard	Small volume purchase from retail yard
Inches				
5/8	Chicago	318	333	362
	Los Angeles	314	329	357
	Wash., D.C.	320	335	364
3/4	Chicago	394	412	448
	Los Angeles	390	408	443
	Wash., D.C.	401	419	455

Sources: USDA Forest Service, Random Lengths Publications, Inc., and Western Wood Products Association.

Table 21.--Wage rates, including fringe benefits, for wood floor framing in residential construction, 1973 dollars

Area	Carpenter wages		Laborer wages	
	Per hour	Per minute	Per hour	Per minute
Chicago	9.73	0.1622	7.62	0.1270
Los Angeles	8.89	.1482	7.50	.1250
Washington, D.C.	8.24	.1373	6.60	.1100

Source: U.S. Department of Labor, Bureau of Labor Statistics.

Labor wages

Table 21 presents the union wage rates in the three cities in this study, for the year 1973.

Total in-place cost

Appendix tables 13, 14 and 15 summarize the estimated in-place cost calculations for the installation of 2X8 and 2X10 joists, spaced 16 inches on center and 24 inches on center respectively, for each of three types of builder size. The in-place cost estimates range from $0.85 to $1.00 per square foot of floor area.

ALUMINUM JOIST CONSTRUCTION

Aluminum and plywood quantities

The aluminum and plywood quantities used in this portion of the study were the same as those for the year 1970. Aluminum requirements were 0.82 pounds per square foot of framed area (table 7). Plywood use per square foot of floored area was 1.06 square feet.

Aluminum and plywood prices

Aluminum prices paid by builders in 1973, were taken from "American Metal Market," as described in the first part of the study. The price remained constant for the entire first quarter, at 52.0 cents per pounds for Extrusions, 6061-T6. Following the same procedure used in the first part of this study, the prices paid by the two builder-types considered here were as follows:

	Cents per pound
1973 first quarter aluminum delivered price per pound	52.
Less 15 percent discount	8.
Price per pound paid by large volume builders	44.
1973 first quarter aluminum delivered price per pound	52.
Less 15 percent discount	8.
Price per pound paid by dealer	44.
Plus 25 percent mark-up	11.
Price per pound paid by small volume builder	55.

Plywood prices used for 3/4-inch plywood can be found in table 20.

Labor quantities

Labor quantities for installing 2X8 floor joists spaced 24 inches on center, for the "typical" house, were 0.25 SMM/S.F. (table 8). Labor requirements for plywood installation over aluminum joists were 0.35 SMM/S.F. (table 5), plus 0.07 SMM/S.F. (the estimated labor required to glue and nail plywood to aluminum joists) which totals 0.42 SMM/S.F.

Labor wages

Currently aluminum floor systems are installed by carpentry crews that frame other parts of the house. The wages paid to carpenters and laborers for installing aluminum floors were therefore assumed to be the same as for installing wood floors (table 21).

Total in-place cost

The estimated, in-place cost of an aluminum joist floor system, covered with 3/4-inch plywood, ranged from $0.89 to $1.04 per square foot of floored area. Appendix table 16 gives the costs for the three selected cities, for both large and small builders.

Cost differentials between large builders using 2X8 aluminum joists spaced 24 inches on center, covered with 3/4-inch plywood, and large builders using 2X8 wood joists, spaced 16 inches on center, covered with 5/8-inch plywood, for the three cities are shown in table 22 and graphically for Los Angeles, figure 4.

Table 22.--In-place costs, per square foot of floor area, for wood and aluminum framed floor systems, for large builders in three metropolitan areas, 1973

Area	Floor system		Difference	
	Aluminum 1/	Wood 2/		
	$/S.F.	$/S.F.	$/S.F.	Percent
Chicago	0.90	0.90	0.00	0
Los Angeles	.89	.87	.02	2
Washington, D.C.	.89	.88	.01	1

1/ 2X8 aluminum joist, spaced 24 inches on center
2/ 2X8 wood joist, spaced 16 inches on center

COST OF WOOD AND ALUMINUM WALL FRAMING AT 1973 PRICES

WOOD STUD CONSTRUCTION

Lumber quantities

The lumber requirements for both interior partitions and exterior walls are those for the "typical" house, contained in table 10.

Lumber prices

Lumber prices paid by builders for 2x3 and 2x4 studs were estimated by the same method as described on page 24 that was used in estimating prices builders paid for 2x8's and 2x10's. The results are shown in table 23.

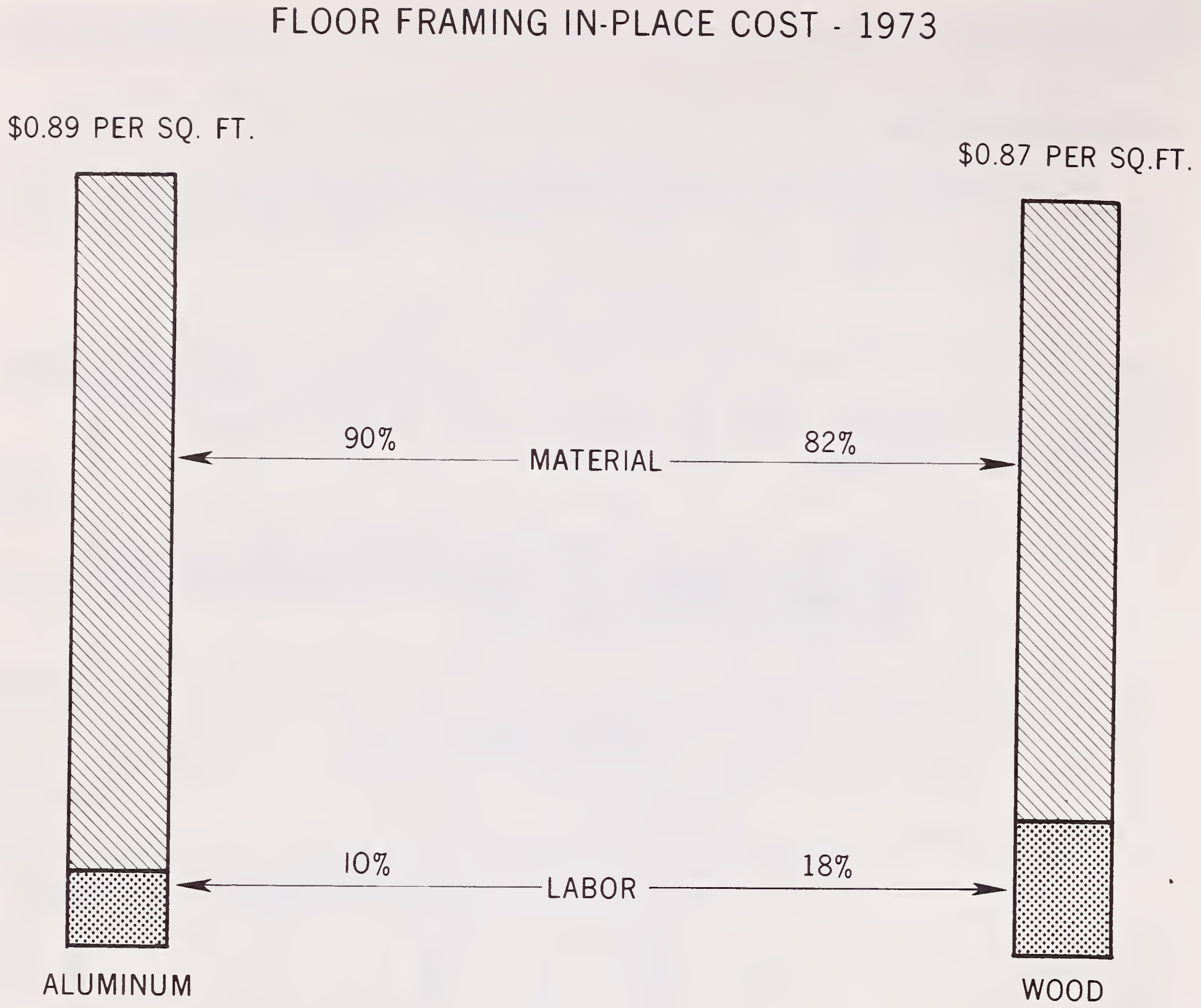


Figure 4.--Aluminum and wood floor framing in-place cost at 1973 prices.

Figure 5 illustrates graphically what happens to floor framing in-place costs when lumber prices increase much more rapidly than aluminum prices over the same period. Lumber prices went from $124 to $240 per thousand board feet during the study period, while aluminum prices increased from $41 to $44 per hundred pounds. The differential cost, which favored wood over aluminum by 18 cents per square foot of floor area at 1970 lumber prices, decreased to about 4 cents by 1973. Thus wood had only a small economic advantage over aluminum during the first quarter of 1973.

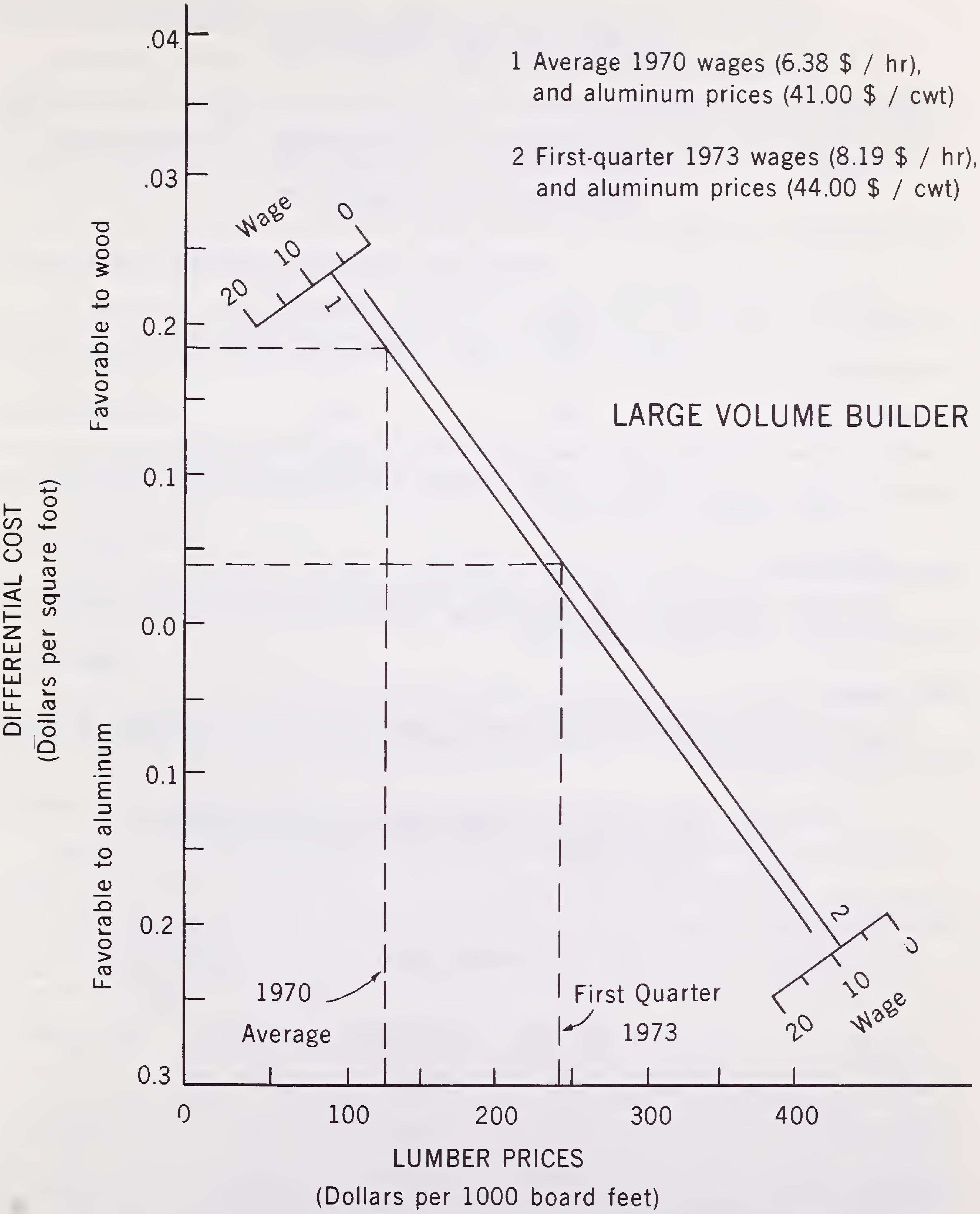


Figure 5.--Differential cost between floors framed with wood versus aluminum at 1970 and 1973 prices.

Table 23.--Estimated prices builders paid for 2X3 and 2X4 stud grade wall framing, 1973

Area	Large volume purchase direct from mill	Large volume purchase from retail yard	Small volume purchase from retail yard
	Dollars per thousand board feet		
Chicago	224	234	255
Los Angeles	212	221	240
Washington, D.C.	227	237	258

Sources: USDA Forest Service, Random Lengths Publications, Inc., and Western Wood Products Association.

Labor quantities

The labor requirements for installing studs in interior partitions and exterior walls are found in table 12.

Labor wages

Wage rates paid for the framing of interior partitions and exterior walls are found in table 24.

Table 24.--Wage rates, including fringe benefits, for wood wall framing in residential construction, 1973 dollars

Area	Carpenter wages		Laborer wages	
	Per hour	Per minute	Per hour	Per minute
Chicago	9.73	0.1622	7.62	0.1270
Los Angeles	8.89	.1482	7.50	.1250
Washington, D.C.	8.24	.1373	6.60	.1100

Source: U.S. Department of Labor, Bureau of Labor Statistics.

Total in-place cost

Appendix tables 17, 18 and 19 present the in-place cost estimates for interior partitions, and appendix tables 21, 22, and 23 present the in-place cost estimates for exterior walls for all builder types. The range in cost estimates for interior partitions was $1.69 to $2.18 per linear foot, and for exterior walls $2.44 to $3.07 per linear foot of wall area framed.

ALUMINUM STUD CONSTRUCTION

Aluminum quantities

The aluminum quantities for interior non-load partitions and exterior walls are found in tables 13, 14 and 15. The quantities in table 14 for a "typical" residence were the amounts used in this study.

Aluminum prices

Aluminum prices per pound by both large and small builders are the same as those paid for aluminum joists and are found on page 26.

Labor quantities

Labor requirements for the erection of interior partitions and exterior walls were the same as those used for 1970, and can be found in table 16.

Labor wages

Labor wage rates used in computing the in-place cost estimates for interior partition and exterior wall framing are the same as those used in floor framing, and can be found in table 24.

Total in-place cost

Appendix table 20 summarizes the in-place cost estimates for the installation of interior partitions. The in-place cost range was from $1.86 to $2.50 per linear foot of wall framed. The most typically used stud size and spacing were the same for aluminum and wood framing, namely, 2X3 stud, spaced 24-inches on center. A comparison among large builders in the three cities studied can be found in table 25, and is graphically shown for Los Angeles in figures 6 and 7.

Appendix table 24 summarizes the in-place cost estimates for the installation of exterior walls. These range from $2.48 to $3.02 per linear foot of wall area framed. The most commonly used spacing for aluminum exterior studs was 24 inches on center, and for wood studs, 16 inches on center. The stud size used by both aluminum and wood builders for framing exterior walls was 2X4, and the comparison for large builders, for the three cities studied, can be found in table 26. There is a distinct cost advantage in the use of aluminum over wood framed exterior walls. Additional data for Los Angeles can be found in figures 8 and 9.

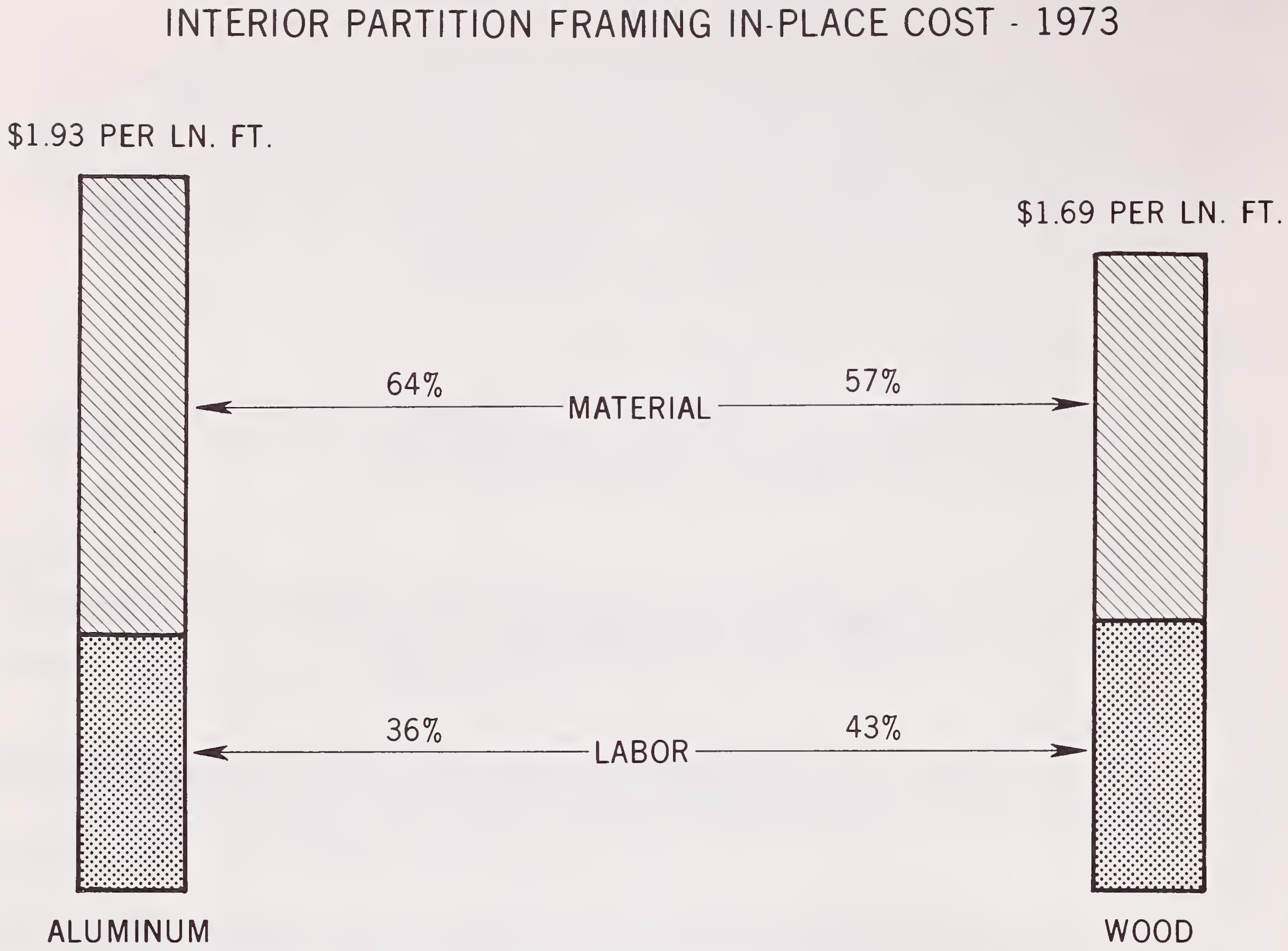


Figure 6.--Aluminum and wood interior partition framing in-place cost at 1973 prices.

Table 25.--In-place costs, per linear foot of wall area, for wood and aluminum framed interior non-load partitions, for large builders in three metropolitan areas, 1973

Area	Wall System		Difference	
	Aluminum 1/	Wood 2/		
	$/L.F.	$/L.F.	$/L.F.	Percent
Chicago	1.97	1.79	0.18	10
Los Angeles	1.93	1.69	.24	14
Washington D.C.	1.86	1.69	.17	10

1/ 2x3 aluminum studs, spaced 24 inches on center
2/ 2x3 wood studs, spaced 24 inches on center

Figure 7 shows the differential cost advantage wood framed interior partitions over aluminum framed partitions during 1970. However, by the first quarter of 1973, wood's advantage had dropped from 70 to 25 cents per linear foot of wall area.

This was primarily brought about by the increase of 2x4 lumber prices from $100 in 1970, to $212 per thousand board feet in the first quarter of 1973.

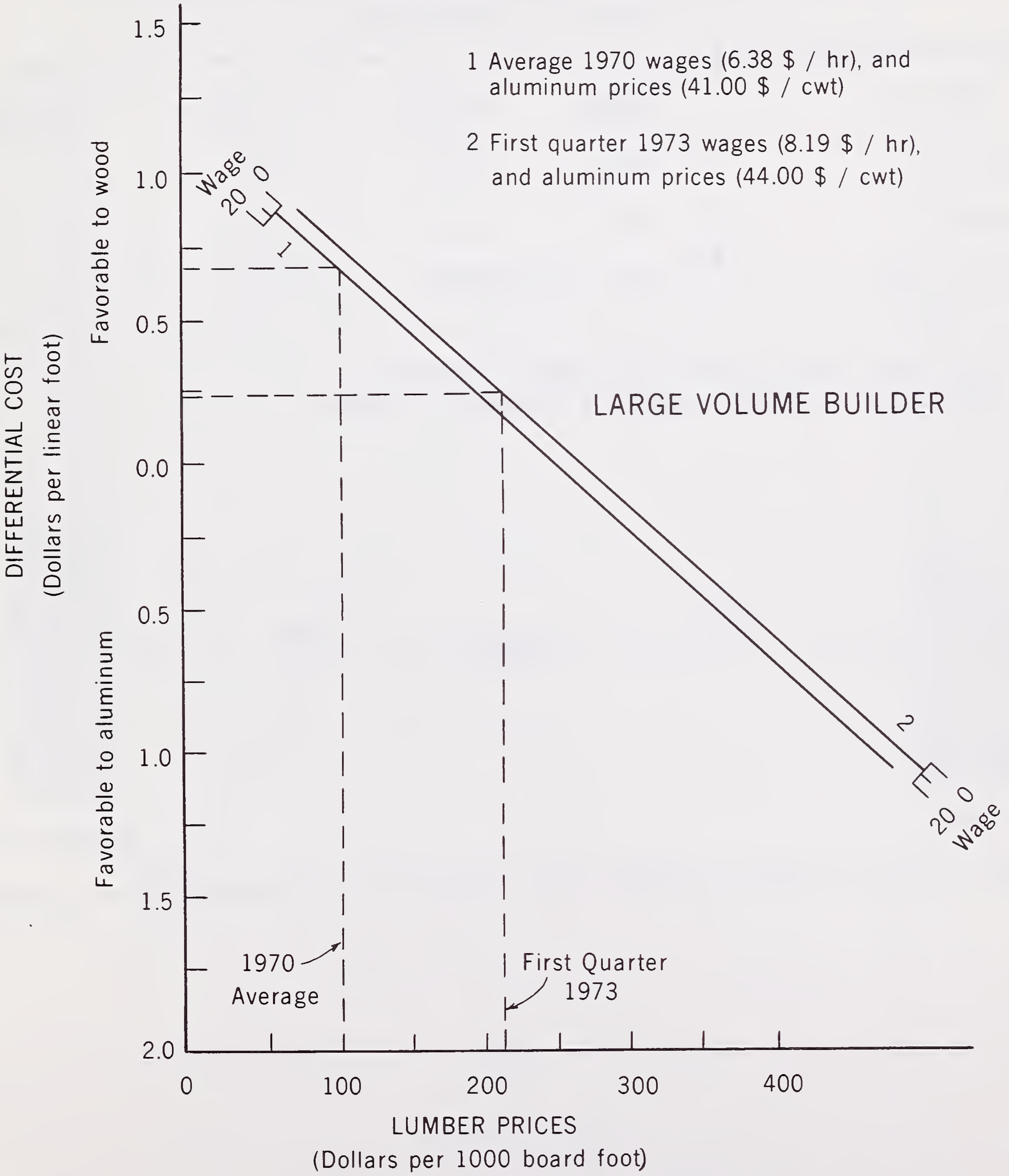


Figure 7.--Differential cost between interior partitions framed with wood versus aluminum at 1970 and 1973 prices.

Table 26.--In-place costs, per linear foot of wall area, for wood and aluminum framed exterior walls, for large builders in three metropolitan areas, 1973

Area	Wall system		Difference	
	Wood 1/	Aluminum 2/		
	$/L.F.	$/L.F.	$/L.F.	Percent
Chicago	2.81	2.63	0.18	7
Los Angeles	2.66	2.57	.09	4
Washington, D.C.	2.70	2.48	.22	9

1/ 2X4 wood studs, spaced 16 inches on center
2/ 2X4 aluminum studs, spaced 24 inches on center

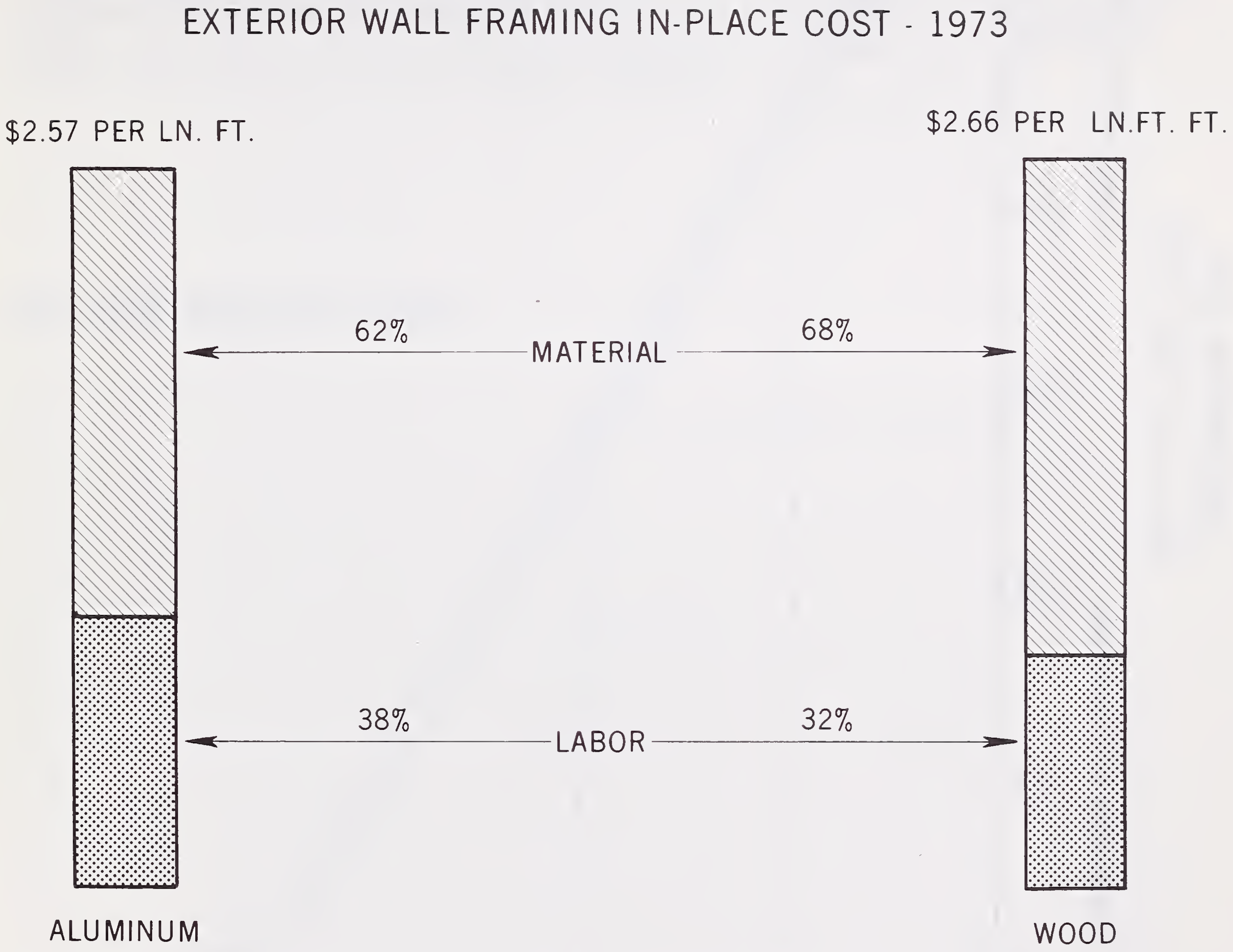


Figure 8.--Aluminum and wood exterior wall framing in-place cost at 1973 prices.

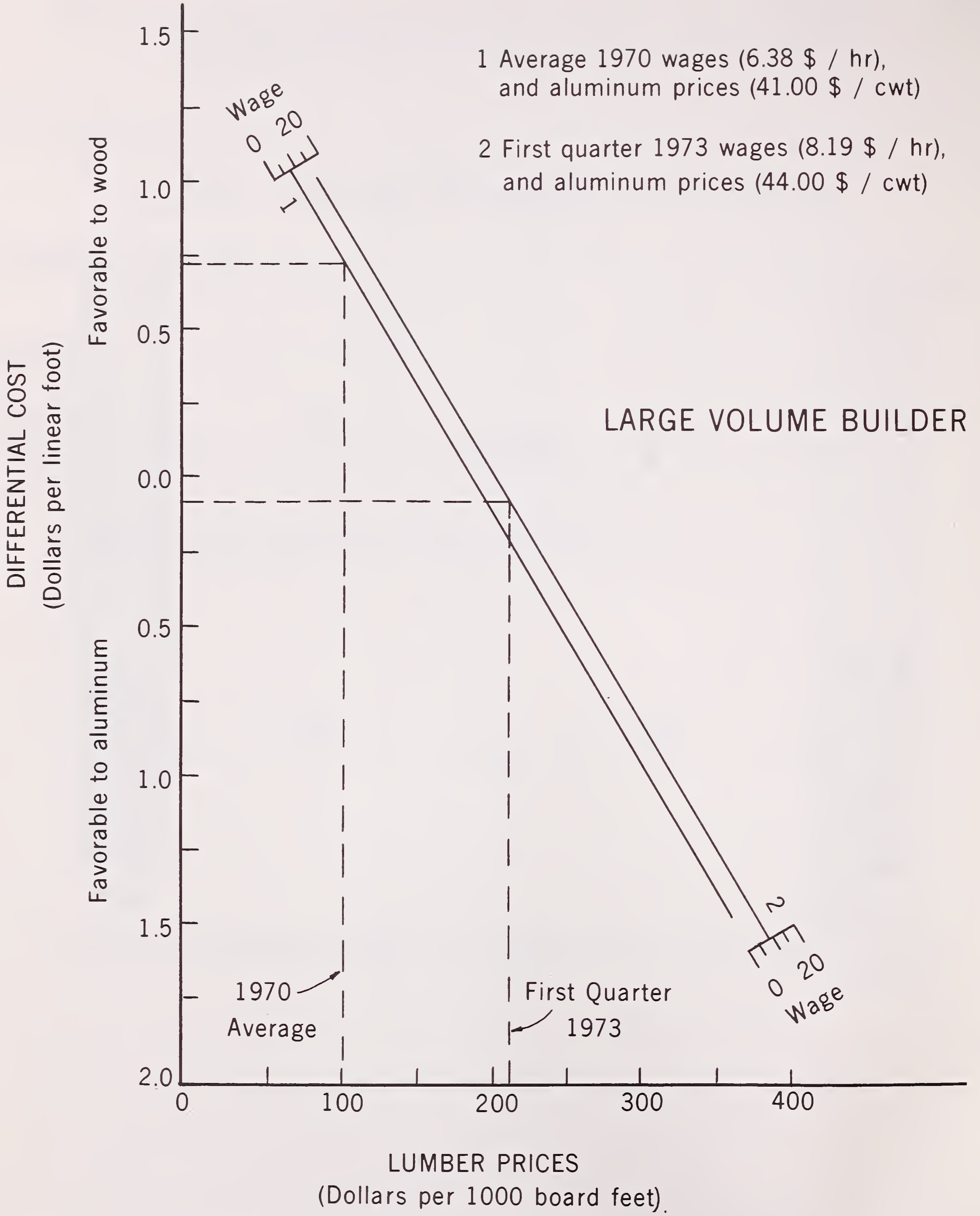


Figure 9.--Differential cost between exterior walls framed with wood versus aluminum at 1970 prices and 1973 prices.

Figure 9 is representative of what happened to in-place prices of wood framed exterior walls for the two study periods, 1970 and the first quarter of 1973.

In 1970, wood framed exterior walls held a 70-cent-per-linear-foot in-place cost advantage over aluminum framed exterior walls. But the large increase in lumber prices, compared to the rather small increase in aluminum prices, placed wood framed exterior walls at an economic disadvantage, when compared to aluminum framed walls in the first quarter of 1973. Aluminum framed walls cost about 10 cents per linear foot less than the wood framed walls during the first quarter of 1973.

APPENDIX

Appendix table 1.--In-place costs per square foot of constructing floors with wood framing and plywood flooring in Chicago, Ill., 1970

Floor system and type builder	Framing							Plywood flooring							Total in-place cost per square foot of floor
	Materials			Labor			Total cost per square foot of floor	Materials			Labor			Total cost per square foot of floor	
	Per square foot of floor	Price per board foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		Per square foot of floor	Price per square foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		
	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Square feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Dollars
2x8 joist spaced 16 inches on center and 5/8-inch plywood flooring 1/															
Large volume builder purchasing lumber directly from mill	1.55	0.137	0.212	0.70	0.1059	0.074	0.286	1.06	0.167	0.177	0.45	0.1059	0.048	0.225	0.511
Large volume builder purchasing lumber from retail yard	1.55	.143	.222	.70	.1059	.074	.296	1.06	.175	.186	.45	.1059	.048	.234	.530
Small volume builder purchasing lumber from retail yard	1.55	.156	.242	.70	.1059	.074	.316	1.06	.190	.201	.45	.1059	.048	.249	.565
2x10 joist spaced 24 inches on center and 3/4-inch plywood flooring 1/															
Large volume builder purchasing lumber directly from mill	1.25	.148	.185	.55	.1059	.058	.243	1.06	.191	.202	.35	.1059	.037	.239	.482
Large volume builder purchasing lumber from retail yard	1.25	.155	.194	.55	.1059	.058	.252	1.06	.200	.212	.35	.1059	.037	.249	.501
Small volume builder purchasing lumber from retail yard	1.25	.168	.210	.55	.1059	.058	.268	1.06	.217	.230	.35	.1059	.037	.267	.535

---

[1] All lumber is assumed to be No. 2 or better, S-dry. Species grades are assumed to be Douglas-fir, Douglas-fir-larch, Hem-fir, or Southern pine. Plywood is assumed to be T&G--2 edges, Underlayment Exterior grade, Group 1 or 2. Minimum thickness permitted for joist spacing of 16 inches on center is 1/2-inch plywood, but builders typically use 5/8-inch.

Appendix table 2.--In-place costs per square foot of constructing floors with wood framing and plywood flooring in Los Angeles, Calif., 1970

Floor system and type builder	Framing							Plywood flooring							Total in-place cost per square foot of floor
	Materials			Labor			Total cost per square foot of floor	Materials			Labor			Total cost per square foot of floor	
	Per square foot of floor	Price per board foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		Per square foot of floor	Price per square foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		
	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Square feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Dollars
2x8 joist spaced 16 inches on center and 5/8-inch plywood flooring 1/															
Large volume builder purchasing lumber directly from mill	1.55	0.124	0.192	0.70	0.1064	0.074	0.266	1.06	0.159	0.169	0.45	0.1064	0.048	0.217	0.483
Large volume builder purchasing lumber from retail yard	1.55	.129	.200	.70	.1064	.074	.274	1.06	.166	.176	.45	.1064	.048	.224	.498
Small volume builder purchasing lumber from retail yard	1.55	.141	.219	.70	.1064	.074	.293	1.06	.180	.191	.45	.1064	.048	.239	.532
2x10 joist spaced 24 inches on center and 3/4-inch plywood flooring 1/															
Large volume builder purchasing lumber directly from mill	1.25	.133	.166	.55	.1064	.059	.225	1.06	.180	.191	.35	.1064	.037	.228	.453
Large volume builder purchasing lumber from retail yard	1.25	.139	.174	.55	.1064	.059	.233	1.06	.188	.199	.35	.1064	.037	.236	.469
Small volume builder purchasing lumber from retail yard	1.25	.151	.189	.55	.1064	.059	.248	1.06	.205	.217	.35	.1064	.037	.254	.502

---

[1] All lumber is assumed to be No. 2 or better, S-dry. Species grades are assumed to be Douglas-fir, Douglas-fir-larch, Hem-fir, or Southern pine. Plywood is assumed to be T&G--2 edges, Underlayment Exterior grade, Group 1 or 2. Minimum thickness permitted for joist spacing of 16 inches on center is 1/2-inch plywood, but builders typically use 5/8-inch.

Appendix table 3.--In-place costs per square foot of constructing floors with wood framing and plywood flooring in Washington, D.C., 1970

Floor system and type builder	Framing							Plywood flooring							Total in-place cost per square foot of floor
	Materials			Labor			Total cost per square foot of floor	Materials			Labor			Total cost per square foot of floor	
	Per square foot of floor	Price per board foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		Per square foot of floor	Price per square foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		
	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Square feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Dollars
2x8 joist spaced 16 inches on center and 5/8-inch plywood flooring 1/															
Large volume builder purchasing lumber directly from mill	1.55	0.133	0.206	0.70	0.0893	0.063	0.269	1.06	0.172	0.182	0.45	0.0893	0.040	0.222	0.491
Large volume builder purchasing lumber from retail yard	1.55	.139	.215	.70	.0893	.063	.278	1.06	.180	.191	.45	.0893	.040	.231	.509
Small volume builder purchasing lumber from retail yard	1.55	.151	.234	.70	.0893	.063	.297	1.06	.195	.207	.45	.0893	.040	.247	.544
2x10 joist spaced 24 inches on center and 3/4-inch plywood flooring 1/															
Large volume builder purchasing lumber directly from mill	1.25	.144	.180	.55	.0893	.049	.229	1.06	.197	.209	.35	.0893	.031	.240	.469
Large volume builder purchasing lumber from retail yard	1.25	.151	.189	.55	.0893	.049	.238	1.06	.206	.218	.35	.0893	.031	.249	.487
Small volume builder purchasing lumber from retail yard	1.25	.164	.205	.55	.0893	.049	.254	1.06	.224	.237	.35	.0893	.031	.268	.522

1/ All lumber is assumed to be No. 2 or better, S-dry. Species grades are assumed to be Douglas-fir, Douglas-fir-larch, Hem-fir, or Southern pine. Plywood is assumed to be T&G--2 edges, Underlayment Exterior grade, Group 1 or 2. Minimum thickness permitted for joist spacing of 16 inches on center is 1/2-inch plywood, but builders typically use 5/8-inch.

Appendix table 4.--In-place costs per square foot of constructing floors with aluminum framing and plywood flooring 1/ in three metropolitan areas, 1970

Metropolitan area and type builder	Framing							Plywood flooring							Total in-place cost per square foot of floor
	Materials			Labor			Total cost per square foot of floor	Materials			Labor			Total cost per square foot of floor	
	Per square foot of floor	Price per pound	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		Per square foot of floor	Price per square foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		
	Pounds	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Square feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Dollars
CHICAGO															
Large volume builder purchasing directly from mill	0.82	0.41	0.34	0.25	0.1059	0.026	0.366	1.06	2/0.210	0.223	3/0.42	0.1059	0.044	0.267	0.633
Small volume builder purchasing from retail yard	.82	.51	.42	.25	.1059	.026	.446	1.06	2/ .219	.232	3/ .42	.1059	.044	.276	.722
LOS ANGELES															
Large volume builder purchasing directly from mill	.82	.41	.34	.25	.1064	.027	.367	1.06	2/ .199	.211	3/ .42	.1064	.045	.256	.623
Small volume builder purchasing from retail yard	.82	.51	.42	.25	.1064	.027	.447	1.06	2/ .207	.219	3/ .42	.1064	.045	.264	.711
WASHINGTON, D.C.															
Large volume builder purchasing directly from mill	.82	.41	.34	.25	.0893	.022	.362	1.06	2/ .216	.229	3/ .42	.0893	.038	.267	.629
Small volume builder purchasing from retail yard	.82	.51	.42	.25	.0893	.022	.442	1.06	2/ .225	.238	3/ .42	.0893	.038	.276	.718

1/ 2x8 aluminum joist spaced 24 inches on center; 3/4-inch plywood flooring. Plywood is assumed to be T&G--2 edges, Underlayment Exterior grade, Group 1 or 2.

2/ Includes 0.019 dollars for glue and nails.

3/ Includes 0.07 man-minute for glue and nail labor.

Appendix table 5.--In-place costs per linear foot of wood nonload-bearing partitions framed with 2x3 studs 1/ in Chicago, 1970

Type builder	Stud spacing	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per board foot	Cost per linear foot	Per Linear foot	Wage per man-minute	Cost per linear foot	
	Inches	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
Large volume builder purchasing lumber directly from mill	16	5.04	0.114	0.575	6.20	0.1059	0.657	1.232
Large volume builder purchasing lumber from retail yard	16	5.04	.119	.600	6.20	.1059	.657	1.257
Small volume builder purchasing lumber from retail yard	16	5.04	.129	.650	6.20	.1059	.657	1.307
Large volume builder purchasing lumber directly from mill	24	4.54	.114	.518	5.33	.1059	.564	1.082
Large volume builder purchasing lumber from retail yard	24	4.54	.119	.540	5.33	.1059	.564	1.104
Small volume builder purchasing lumber from retail yard	24	4.54	.129	.586	5.33	.1059	.564	1.150

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 6.--In-place costs per linear foot of wood nonload-bearing partitions framed with 2x3 studs 1/ in Los Angeles, 1970

Type builder	Stud spacing	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per board foot	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
	Inches	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
Large volume builder purchasing lumber directly from mill	16	5.04	0.100	0.504	6.20	0.1064	0.660	1.164
Large volume builder purchasing lumber from retail yard	16	5.04	.105	.529	6.20	.1064	.660	1.189
Small volume builder purchasing lumber from retail yard	16	5.04	.114	.575	6.20	.1064	.660	1.235
Large volume builder purchasing lumber directly from mill	24	4.54	.100	.454	5.33	.1064	.567	1.021
Large volume builder purchasing lumber from retail yard	24	4.54	.105	.477	5.33	.1064	.567	1.044
Small volume builder purchasing lumber from retail yard	24	4.54	.114	.518	5.33	.1064	.567	1.085

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 7.--In-place costs per linear foot of wood nonload-bearing partitions framed with 2x3 studs 1/ in Washington, D.C., 1970

Type builder	Stud spacing	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per board foot	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
	Inches	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
Large volume builder purchasing lumber directly from mill	16	5.04	0.117	0.590	6.20	0.0893	0.554	1.144
Large volume builder purchasing lumber from retail yard	16	5.04	.122	.615	6.20	.0893	.554	1.169
Small volume builder purchasing lumber from retail yard	16	5.04	.133	.670	6.20	.0893	.554	1.224
Large volume builder purchasing lumber directly from mill	24	4.54	.117	.531	5.33	.0893	.476	1.007
Large volume builder purchasing lumber from retail yard	24	4.54	.122	.554	5.33	.0893	.476	1.030
Small volume builder purchasing lumber from retail yard	24	4.54	.133	.604	5.33	.0893	.476	1.080

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 8.--In-place costs per linear foot for aluminum nonload-bearing partitions, 1/ in three metropolitan areas, 1970

Metropolitan area and type builder	Stud size spaced 24 inches on center	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per pound	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
		Pounds	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
CHICAGO								
Large volume builder purchasing directly from mill	2x3	2.80	0.41	1.148	5.10	0.1059	0.540	1.688
	2x4	3.20	.41	1.312	5.10	.1059	.540	1.852
Small volume builder purchasing from retail yard	2x3	2.80	.51	1.428	5.10	.1059	.540	1.968
	2x4	3.20	.51	1.632	5.10	.1059	.540	2.172
LOS ANGELES								
Large volume builder purchasing directly from mill	2x3	2.80	.41	1.148	5.10	.1064	.543	1.691
	2x4	3.20	.41	1.312	5.10	.1064	.543	1.855
Small volume builder purchasing from retail yard	2x3	2.80	.51	1.428	5.10	.1064	.543	1.971
	2x4	3.20	.51	1.632	5.10	.1064	.543	2.175
WASHINGTON, D.C.								
Large volume builder purchasing directly from mill	2x3	2.80	.41	1.148	5.10	.0893	.455	1.603
	2x4	3.20	.41	1.312	5.10	.0893	.455	1.767
Small volume builder purchasing from retail yard	2x3	2.80	.51	1.428	5.10	.0893	.455	1.883
	2x4	3.20	.51	1.632	5.10	.0893	.455	2.087

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 9.--In-place costs per linear foot of wood exterior load-bearing walls framed with 2x4 studs 1/ in Chicago, 1970

Type builder	Stud spacing	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per board foot	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
	Inches	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
Large volume builder purchasing lumber directly from mill	16	8.48	0.114	0.967	6.30	0.1059	0.667	1.634
Large volume builder purchasing lumber from retail yard	16	8.48	.119	1.009	6.30	.1059	.667	1.676
Small volume builder purchasing lumber from retail yard	16	8.48	.129	1.094	6.30	.1059	.667	1.761
Large volume builder purchasing lumber directly from mill	24	7.65	.114	.872	5.98	.1059	.633	1.505
Large volume builder purchasing lumber from retail yard	24	7.65	.119	.910	5.98	.1059	.633	1.543
Small volume builder purchasing lumber from retail yard	24	7.65	.129	.987	5.98	.1059	.633	1.620

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 10.--In-place costs per linear foot of wood exterior load-bearing walls framed with 2x4 studs 1/ in Los Angeles, 1970

Type builder	Stud spacing	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per board foot	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
	Inches	Board feet	Dollars	Dollars	Man-minute	Dollars	Dollars	Dollars
Large volume builder purchasing lumber directly from mill	16	8.48	0.100	0.848	6.30	0.1064	0.670	1.518
Large volume builder purchasing lumber from retail yard	16	8.48	.105	.890	6.30	.1064	.670	1.560
Small volume builder purchasing lumber from retail yard	16	8.48	.114	.967	6.30	.1064	.670	1.637
Large volume builder purchasing lumber directly from mill	24	7.65	.100	.765	5.98	.1064	.636	1.401
Large volume builder purchasing lumber from retail yard	24	7.65	.105	.803	5.98	.1064	.636	1.439
Small volume builder purchasing lumber from retail yard	24	7.65	.114	.872	5.98	.1064	.636	1.508

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 11.--In-place costs per linear foot of wood exterior load-bearing walls framed with 2x4 studs 1/ in Washington, D.C., 1970

Type builder	Stud spacing	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per board foot	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
	Inches	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
Large volume builder purchasing lumber directly from mill	16	8.48	0.117	0.992	6.30	0.0893	0.563	1.555
Large volume builder purchasing lumber from retail yard	16	8.48	.122	1.035	6.30	.0893	.563	1.598
Small volume builder purchasing lumber from retail yard	16	8.48	.133	1.128	6.30	.0893	.563	1.691
Large volume builder purchasing lumber directly from mill	24	7.65	.117	.895	5.98	.0893	.534	1.429
Large volume builder purchasing lumber from retail yard	24	7.65	.122	.933	5.98	.0893	.534	1.467
Small volume builder purchasing lumber from retail yard	24	7.65	.133	1.017	5.98	.0893	.534	1.551

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 12.--In-place costs per linear foot of aluminum framing (2x4, 24 inches on center) for exterior load-bearing walls, 1/ in three metropolitan areas, 1970

Metropolitan area and type builder	Materials			Labor			Total in-place cost per linear foot
	Per linear foot	Price per pound	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
	Pounds	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
CHICAGO							
Large volume builder purchasing directly from mill	3.60	0.41	1.476	7.20	0.1059	0.762	2.238
Small volume builder purchasing from retail yard	3.60	.51	1.836	7.20	.1059	.762	2.598
LOS ANGELES							
Large volume builder purchasing directly from mill	3.60	.41	1.476	7.20	.1064	.766	2.242
Small volume builder purchasing from retail yard	3.60	.51	1.836	7.20	.1064	.766	2.602
WASHINGTON, D.C.							
Large volume builder purchasing directly from mill	3.60	.41	1.476	7.20	.0893	.643	2.119
Small volume builder purchasing from retail yard	3.60	.51	1.836	7.20	.0893	.643	2.479

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 13.--In-place costs per square foot of constructing floors with wood framing and plywood flooring in Chicago, Ill., 1973

Floor system and type builder	Framing							Plywood flooring							Total in-place cost per square foot of floor
	Materials			Labor			Total cost per square foot of floor	Materials			Labor			Total cost per square foot of floor	
	Per square foor of floor	Price per board foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		Per square foot of floor	Price per square foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		
	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Square feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Dollars
2x8 joist spaced 16 inches on center and 5/8-inch plywood flooring 1/															
Large volume builder purchasing lumber directly from mill	1.55	0.255	0.395	0.70	0.1446	0.101	0.496	1.06	0.318	0.337	0.45	0.1446	0.065	0.402	0.898
Large volume builder purchasing lumber from retail yard	1.55	.266	.412	.70	.1446	.101	.513	1.06	.332	.352	.45	.1446	.065	.417	.930
Small volume builder purchasing lumber from retail yard	1.55	.290	.449	.70	.1446	.101	.550	1.06	.362	.384	.45	.1446	.065	.449	.999
2x10 joist spaced 24 inches on center and 3/4-inch plywood flooring 1/															
Large volume builder purchasing lumber directly from mill	1.25	.267	.334	.55	.1446	.080	.414	1.06	.394	.418	.35	.1446	.051	.469	.883
Large volume builder purchasing lumber from retail yard	1.25	.279	.349	.55	.1446	.080	.429	1.06	.412	.438	.35	.1446	.051	.489	.918
Small volume builder purchasing lumber from retail yard	1.25	.303	.379	.55	.1446	.080	.459	1.06	.448	.475	.35	.1446	.051	.526	.974

1/ All lumber is assumed to be No. 2 or better, S-dry. Species grades are assumed to be Douglas-fir, Douglas-fir-larch, Hem-fir, or Southern pine. Plywood is assumed to be T&G--2 edges, Underlayment Exterior grade, Group 1 or 2. Minimum thickness permitted for joist spacing of 16 inches on center is 1/2-inch plywood, but builders typically use 5/8-inch.

Appendix table 14.--In-place costs per square foot of constructing floors with wood framing and plywood flooring in Los Angeles, Calif., 1973

Floor system and type builder	Framing							Plywood flooring							Total in-place cost per square foot of floor
	Materials			Labor			Total cost per square foot of floor	Materials			Labor			Total cost per square foot of floor	
	Per square foot of floor	Price per board foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		Per square foot of floor	Price per square foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		
	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Square feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Dollars
2x8 joist spaced 16 inches on center and 5/8-inch plywood flooring 1/															
Large volume builder purchasing lumber directly from mill	1.55	0.243	0.377	0.70	0.1366	0.096	0.473	1.06	0.314	0.333	0.45	0.1366	0.061	0.394	0.867
Large volume builder purchasing lumber from retail yard	1.55	.254	.394	.70	.1366	.096	.490	1.06	.329	.349	.45	.136	.061	.410	.900
Small volume builder purchasing lumber from retail yard	1.55	.276	.428	.70	.1366	.096	.524	1.06	.357	.378	.45	.1366	.061	.439	.963
2x10 joist spaced 24 inches on center and 3/4-inch plywood flooring 1/															
Large volume builder purchasing lumber directly from mill	1.25	.255	.319	.55	.1366	.075	.394	1.06	.390	.413	.35	.1366	.048	.461	.855
Large volume builder purchasing lumber from retail yard	1.25	.267	.334	.55	.1366	.075	.409	1.06	.408	.432	.35	.1366	.048	.480	.889
Small volume builder purchasing lumber from retail yard	1.25	.290	.362	.55	.1366	.075	.437	1.06	.443	.470	.35	.1366	.048	.518	.955

1/ All lumber is assumed to be No. 2 or better, S-dry. Species grades are assumed to be Douglas-fir, Douglas-fir-larch, Hem-fir, or Southern pine. Plywood is assumed to be T&G--2 edges, Underlayment Exterior grade, Group 1 or 2. Minimum thickness permitted for joist spacing of 16 inches on center is 1/2-inch plywood, but builders typically use 5/8-inch.

Appendix table 15.--In-place costs per square foot of constructing floors with wood framing and plywood flooring in Washington, D.C., 1973

Floor system and type builder	Framing							Plywood flooring							Total in-place cost per square foot of floor
	Materials			Labor			Total cost per square foot of floor	Materials			Labor			Total cost per square foot of floor	
	Per square foot of floor	Price per board foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		Per square foot of floor	Price per square foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor		
	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Square feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Dollars
2x8 joist spaced 16 inches on center and 5/8-inch plywood flooring 1/															
Large volume builder purchasing lumber directly from mill	1.55	0.257	0.398	0.70	0.1237	0.087	0.485	1.06	0.320	0.339	0.45	0.1237	0.056	0.395	0.880
Large volume builder purchasing lumber from retail yard	1.55	.269	.417	.70	.1237	.087	.504	1.06	.335	.355	.45	.1237	.056	.411	.915
Small volume builder purchasing lumber from retail yard	1.55	.292	.453	.70	.1237	.087	.540	1.06	.364	.386	.45	.1237	.056	.442	.982
2x10 joist spaced 24 inches on center and 3/4-inch plywood flooring 1/															
Large volume builder purchasing lumber directly from mill	1.25	.269	.336	.55	.1237	.068	.404	1.06	.401	.425	.35	.1237	.043	.468	.872
Large volume builder purchasing lumber from retail yard	1.25	.282	.352	.55	.1237	.068	.420	1.06	.419	.444	.35	.1237	.043	.487	.907
Small volume builder purchasing lumber from retail yard	1.25	.306	.382	.55	.1237	.068	.450	1.06	.455	.482	.35	.1237	.043	.525	.980

1/ All lumber is assumed to be No. 2 or better, S-dry. Species grades are assumed to be Douglas-fir, Douglas-fir larch, Hem-fir, or Southern pine. Plywood is assumed to be T&G--2 edges, Underlayment Exterior grade, Group 1 or 2. Minimum thickness permitted for joist spacing of 16 inches on center is 1/2-inch plywood, but builders typically use 5/8-inch.

Appendix table 16.--In-place costs per square foot of constructing floors with aluminum framing and plywood flooring 1/ in three metropolitan areas, 1973

Metropolitan area and type builder	Framing							Plywood flooring							Total in-place cost per square foot of floor
	Materials			Labor				Materials			Labor				
	Per square foot of floor	Price per pound	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor	Total cost per square foot of floor	Per square foot of floor	Price per square foot	Cost per square foot of floor	Per square foot of floor	Wage per man-minute	Cost per square foot of floor	Total cost per square foot of floor	
	Pounds	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Square feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars	Dollars
CHICAGO															
Large volume builder purchasing directly from mill	0.82	0.44	0.36	0.25	0.1446	0.036	0.396	1.06	2/0.413	0.438	3/0.42	0.1446	0.061	0.499	0.895
Small volume builder purchasing from retail yard	.82	.55	.45	.25	.1446	.036	.486	1.06	2/ .467	.495	3/ .42	.1446	.061	.556	1.042
LOS ANGELES															
Large volume builder purchasing directly from mill	.82	.44	.36	.25	.1336	.034	.394	1.06	2/ .409	.434	3/ .42	.1366	.057	.491	.885
Small volume builder purchasing from retail yard	.82	.55	.45	.25	.1366	.034	.484	1.06	2/ .462	.490	3/ .42	.1366	.057	.547	1.031
WASHINGTON, D.C.															
Large volume builder purchasing directly from mill	.82	.44	.36	.25	.1237	.031	.391	1.06	2/ .420	.445	3/ .42	.1237	.052	.497	.888
Small volume builder purchasing from retail yard	.82	.55	.45	.25	.1237	.031	.481	1.06	2/ .474	.502	3/ .42	.1237	.052	.554	1.035

1/ 2x8 aluminum joist spaced 24 inches on center; 3/4-inch plywood flooring. Plywood is assumed to be T&G--2 edges, Underlayment Exterior grade, Group 1 or 2.

2/ Includes 0.019 dollars for glue and nails.

3/ Includes 0.07 man-minute for glue and nail labor.

Appendix table 17.--In-place costs per linear foot of wood nonload-bearing partitions framed with 2x3 studs 1/ in Chicago, 1973

Type builder	Stud spacing	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per board foot	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
	Inches	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
Large volume builder purchasing lumber directly from mill	16	5.04	0.224	1.129	6.20	0.1446	0.897	2.026
Large volume builder purchasing lumber from retail yard	16	5.04	.234	1.179	6.20	.1446	.897	2.076
Small volume builder purchasing lumber from retail yard	16	5.04	.255	1.285	6.20	.1446	.897	2.182
Large volume builder purchasing lumber directly from mill	24	4.54	.224	1.017	5.33	.1446	.771	1.788
Large volume builder purchasing lumber from retail yard	24	4.54	.234	1.062	5.33	.1446	.771	1.833
Small volume builder purchasing lumber from retail yard	24	4.54	.255	1.158	5.33	.1446	.771	1.929

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 18.--In-place costs per linear foot of wood nonload-bearing partitions framed with 2x3 studs 1/ in Los Angeles, 1973

Type builder	Stud spacing	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per board foot	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
	Inches	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
Large volume builder purchasing lumber directly from mill	16	5.04	0.212	1.068	6.20	0.1366	0.847	1.915
Large volume builder purchasing lumber from retail yard	16	5.04	.221	1.114	6.20	.1366	.847	1.961
Small volume builder purchasing lumber from retail yard	16	5.04	.240	1.210	6.20	.1366	.847	2.057
Large volume builder purchasing lumber directly from mill	24	4.54	.212	0.962	5.33	.1366	.728	1.690
Large volume builder purchasing lumber from retail yard	24	4.54	.221	1.003	5.33	.1366	.728	1.731
Small volume builder purchasing lumber from retail yard	24	4.54	.240	1.090	5.33	.1366	.728	1.818

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 19.--In-place costs per linear foot of wood nonload-bearing partitions framed with 2x3 studs 1/ in Washington, D.C., 1973

Type builder	Stud spacing	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per board foot	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
	Inches	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
Large volume builder purchasing lumber directly from mill	16	5.04	0.227	1.144	6.20	0.1237	0.767	1.911
Large volume builder purchasing lumber from retail yard	16	5.04	.237	1.194	6.20	.1237	.767	1.961
Small volume builder purchasing lumber from retail yard	16	5.04	.258	1.300	6.20	.1237	.767	2.067
Large volume builder purchasing lumber directly from mill	24	4.54	.227	1.031	5.33	.1237	.659	1.690
Large volume builder purchasing lumber from retail yard	24	4.54	.237	1.076	5.33	.1237	.659	1.735
Small volume builder purchasing lumber from retail yard	24	4.54	.258	1.171	5.33	.1237	.659	1.830

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 20.--In-place costs per linear floor for aluminum nonload-bearing partitions, 1/ in three metropolitan areas, 1973

Metropolitan area and type builder	Stud size spaced 24 inches on center	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per pound	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
		Pounds	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
CHICAGO								
Large volume builder purchasing directly from mill	2x3	2.80	0.44	1.232	5.10	0.1446	0.737	1.969
	2x4	3.20	.44	1.408	5.10	.1446	.737	2.145
Small volume builder purchasing from retail yard	2x3	2.80	.55	1.540	5.10	.1446	.737	2.277
	2x4	3.20	.55	1.760	5.10	.1446	.737	2.497
LOS ANGELES								
Large volume builder purchasing directly from mill	2x3	2.80	.44	1.232	5.10	.1366	.697	1.929
	2x4	3.20	.44	1.408	5.10	.1366	.697	2.105
Small volume builder purchasing from retail yard	2x3	2.80	.55	1.540	5.10	.1366	.697	2.237
	2x4	3.20	.55	1.760	5.10	.1366	.697	2.457
WASHINGTON, D.C.								
Large volume builder purchasing directly from mill	2x3	2.80	.44	1.232	5.10	.1237	.631	1.863
	2x4	3.20	.44	1.408	5.10	.1237	.631	2.039
Small volume builder purchasing from retail yard	2x3	2.80	.55	1.540	5.10	.1237	.631	2.171
	2x4	3.20	.55	1.760	5.10	.1237	.631	2.391

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 21.--In-place costs per linear foot of wood exterior load-bearing walls framed with 2x4 studs 1/ in Chicago, 1973

Type builder	Stud spacing	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per board foot	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
	Inches	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
Large volume builder purchasing lumber directly from mill	16	8.48	0.224	1.900	6.30	0.1446	0.911	2.811
Large volume builder purchasing lumber from retail yard	16	8.48	.234	1.984	6.30	.1446	.911	2.895
Small volume builder purchasing lumber from retail yard	16	8.48	.255	2.162	6.30	.1446	.911	3.073
Large volume builder purchasing lumber directly from mill	24	7.65	.224	1.714	5.98	.1446	.865	2.579
Large volume builder purchasing lumber from retail yard	24	7.65	.234	1.790	5.98	.1446	.865	2.655
Small volume builder purchasing lumber from retail yard	24	7.65	.255	1.951	5.98	.1446	.865	2.816

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 22.--In-place costs per linear foot of wood exterior load-bearing walls framed with 2x4 studs 1/ in Los Angeles, 1973

Type builder	Stud spacing	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per board foot	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
	Inches	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
Large volume builder purchasing lumber directly from mill	16	8.48	0.212	1.798	6.30	0.1366	0.861	2.659
Large volume builder purchasing lumber from retail yard	16	8.48	.221	1.874	6.30	.1366	.861	2.735
Small volume builder purchasing lumber from retail yard	16	8.48	.240	2.035	6.30	.1366	.861	2.896
Large volume builder purchasing lumber directly from mill	24	7.65	.212	1.622	5.98	.1366	.817	2.439
Large volume builder purchasing lumber from retail yard	24	7.65	.221	1.691	5.98	.1366	817	2.508
Small volume builder purchasing lumber from retail yard	24	7.65	.240	1.836	5.98	.1366	.817	2.653

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 23.--In-place costs per linear foot of wood exterior load-bearing walls framed with 2x4 studs 1/ in Washington, D.C., 1973

Type builder	Stud spacing	Materials			Labor			Total in-place cost per linear foot
		Per linear foot	Price per board foot	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
	Inches	Board feet	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
Large volume builder purchasing lumber directly from mill	16	8.48	0.227	1.925	6.30	0.1237	0.779	2.704
Large volume builder purchasing lumber from retail yard	16	8.48	.237	2.010	6.30	.1237	.779	2.789
Small volume builder purchasing lumber from retail yard	16	8.48	.258	2.188	6.30	.1237	.779	2.967
Large volume builder purchasing lumber directly from mill	24	7.65	.227	1.737	5.98	.1237	.740	2.477
Large volume builder purchasing lumber from retail yard	24	7.65	.237	1.813	5.98	.1237	.740	2.553
Small volume builder purchasing lumber from retail yard	24	7.65	.258	1.974	5.98	.1237	.740	2.714

1/ Includes door and window openings except door openings extending to the ceiling.

Appendix table 24.--In-place costs per linear foot of aluminum framing (2x4, 24 inches on center) for exterior load-bearing walls, 1/ in three metropolitan areas, 1973

Metropolitan area and type builder	Materials			Labor			Total in-place cost per linear foot
	Per linear foot	Price per pound	Cost per linear foot	Per linear foot	Wage per man-minute	Cost per linear foot	
	Pounds	Dollars	Dollars	Man-minutes	Dollars	Dollars	Dollars
CHICAGO							
Large volume builder purchasing directly from mill	3.60	0.44	1.584	7.20	0.1446	1.041	2.625
Small volume builder purchasing from retail yard	3.60	.55	1.980	7.20	.1446	1.041	3.021
LOS ANGELES							
Large volume builder purchasing directly from mill	3.60	.44	1.584	7.20	.1366	.984	2.568
Small volume builder purchasing from retail yard	3.60	.55	1.980	7.20	.1366	.984	2.964
WASHINGTON, D.C.							
Large volume builder purchasing directly from mill	3.60	.44	1.584	7.20	.1237	.891	2.475
Small volume builder purchasing from retail yard	3.60	.55	1.980	7.20	.1237	.891	2.871

1/ Includes door and window openings except door openings extending to the ceiling.

U.S. GOVERNMENT PRINTING OFFICE : 1975 O - 579-419